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Rebuilding an Old English Foundry

How Progressive British Manufacturer Modernized Foundry Without Loss of Production—American Equipment Installed—Historic Old Jib Cranes Superseded by Modern Travelers on Dual Runway

BY H. COLE ESTEP

European Manager of The Foundry

AMONG the numerous thriving centers of industry whose activities have assisted in making the products of British factories familiar to all the world, one of the most important is the old city of Leicester. With a population of 250,000 and a favorable location on the southern edge of the famous Midlands of England, Leicester was well known as a manufacturing center a thousand years ago. Textiles were woven here in the thirteenth century. Today the words "leather" and "Leicester" are almost synonymous. But in addition to the leather, textile and hosiery industries, Leicester is also numbered among the leading English engineering and iron foundry centers. Prominent among the firms which have contributed to Leictser's progress in this latter field is the firm of W. Richards & Son, operating what is known locally as the Phoenix Iron Works. This business as it stands today is the result of three generations of effort. It was founded three quarters of a century ago, in 1844, by William Richards, the father of the present senior partner. The firm of W. Richards & Son—the name has never been changed—is still a private partnership, the owners being H. W. H. Richards, son of the founder, and his two sons, W. Richards and F. H. Richards.

Foundry work has always constituted one of the most important branches of the firm's activities. From very small beginnings the output of castings has grown to upwards of 300 tons a month. Although surrounded by traditions running back nearly a century, the firm always has pursued progressive technical policies. The Phoenix Iron Works was one of the first concerns in Great Britain to install molding machines and other modern facilities for saving labor and cutting the cost of production. Some of the first American molding machines to be used in England were purchased by W. Richards & Son.

At the present time the firm employs about 300 men, of whom about 120 are engaged in the foundry. W. Richard & Son are engaged in what is known in England as a general engineering business—combining the activities of manufacturing and jobbing machine shops, structural shops and foundries. Machinery of various kinds is constructed together with boilers and plate and tank works. A specialty is made of bridge and structural-steel work, particularly for railroads, while in the foundry, in addition to general jobbing work, particular attention is paid to castings for railway purposes, crane beds, engine castings, millwright's castings and machine-tool castings. Motor frames also are

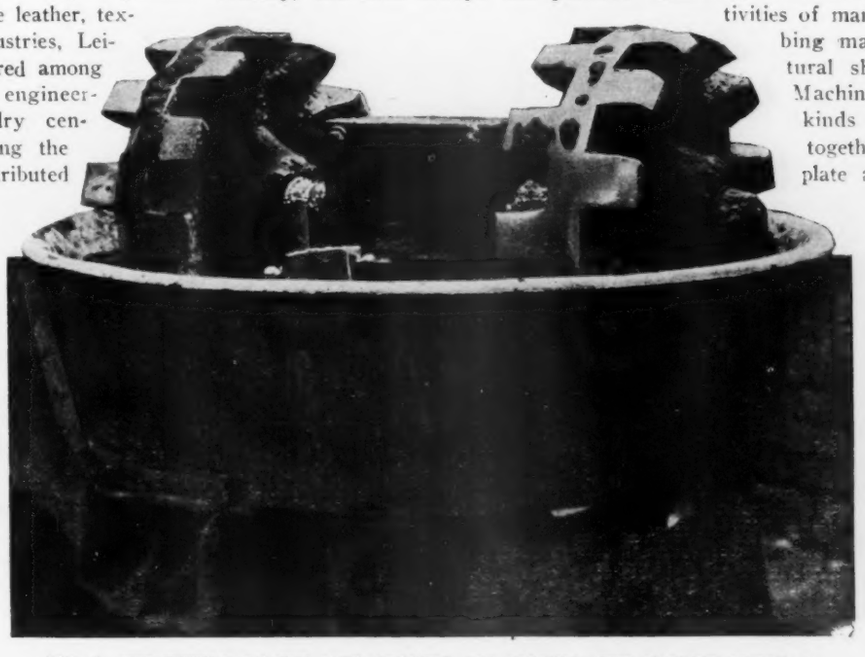

FIG. 1—THE WHEELS OF THE SAND MULLERS ARE TOOTHED—THE MACHINE ITSELF IS MOTOR-DRIVEN

cast from iron having special electrical properties. The motor and electric generator frames range in size from 200 pounds to 7 tons. The foundry is equipped to make castings up to 25 tons.

When the Richards plant was moved some forty-seven years ago to its present location in Leicester, a foundry was among the first buildings constructed. As time went on it was gradually enlarged and extended, and the equipment improved to meet changing conditions. Recently the old shop was completely rebuilt and brought thoroughly up to date. The rebuilding operations were conducted without interfering with the operations of the plant. No heats were lost. The necessary structural work of course was handled by the structural steel department of the Richards firm.

The new foundry is 50 feet wide and 250 feet long. The old building had the same dimensions but was much lower. The eaves formerly were only 14 feet from the floor. A new roof of the monitor type was built and the eaves were raised 26 feet, giving ample headroom over the molding floor for handling the bulkiest castings. This work was done without shutting down the plant. Thorough ventilation has been insured by fitting cast-iron louvers in the sides of the monitor; this, coupled with the great height of the roof, has resulted in the shop being constantly free from gases, smoke and fumes, even during the casting period. A skylight 12 feet wide extends the full length of the roof on each side of the monitor. In addition there are nine 6 x 12-foot windows in each side of the building. The walls are painted white inside, a rather unusual proceedure for a foundry. As a result there is an abundance of daylight in the molding room all the time and the molders are not at any period of the day obliged to work with annoying shadows. Perhaps the most striking change in the rebuilt shop is in the arrangements for handling materials, particularly the crane equipment. The old plant, with its low, timber-framed roof was provided with hand-operated jib cranes. The rebuilt shop is equipped with two modern electric traveling cranes, supplemented by steel jib cranes arranged along the walls. To insure the utmost flexibility, two crane runways, one above the other, have been provided in the new shop. The lower runway is 24 feet from the floor and the upper one 32½-feet. The upper crane hook has a lift of 29 feet and the lower one a lift of 21 feet. The capacity of each crane is 15 tons. The upper crane can readily pass over the lower one and, therefore, they do not interfere with each other when at work to the extent they would if they had both been placed on the same runway. The extra expense of the two runways seems to have been fully justified from the operating results achieved.

FIG. 2—ONE OF THE OLD CRANES SHOWING HAND WINDLASS AND CHAIN HOISTING GEAR

The tremendous contrast between the old and new foundries is clearly shown in Figs. 3 and 4, the former showing the old shop and the latter the new one after the roof had been raised and the new equipment installed.

The details regarding the old jib-cranes shown in Fig. 3 are, of interest, from the historical if from no other point of view. These old cranes and the methods which went with them represent a passing phase in foundry practice which soon will be lost to the present generation. When the old foundry, as shown in Fig. 3, was first built on its present site nearly 50 years ago, it was no less up to date than is the new one today with its double runways, skylights and clean white walls. In fact, from the standpoint of 1873, the old foundry was unusually completely equipped, its several jib cranes being so arranged that heavy castings and other burdens could be passed from one to the other the full length of the molding floor. These old cranes each had a capacity of 10 tons. The columns were solid English oak 24 inches square. It would be virtually impossible to ob-

Men Who Stay On the Job

LABOR turnover, the employment manager's nightmare, has few terrors for the firm of W. Richards & Son in Leicester, England. In the foundry and other shops operated by this concern many men have been on the payroll continuously for fifteen or more years; some of the veterans are approaching the half century mark. Death figures about as prominently in the firm's employment records as resignations. This unusual stability is the result of liberal policies of management working in conjunction with the British character. Below are the names of some of the employes who have been on the job ten years or more, with their lengths of service. Few firms can display such a roll of honor.

Name	Years in Service
*Oldham	53
Bright	49
Spence	45
*Browitt	41
*Timson	40
Wells	40
†Jayes	39
†Bates	38
Tapley	38
Rawlings	38
Wood, J.	36
Lowe, C. A.	33
*Collis	34
*Blower	34
Slater, H.	33
Bollard, T.	33
Pickering	32
Garner, J.	32
Cooper, J.	30
†Cooper, W	28
Withers	28
Goodman	27
Goodman, T.	26
*Heaps	26
†Whitworth	26
Watkin	26
Adcock, T.	26

Name	Years in Service
Newitt, J. W.	26
†Woods	25
Bosworth, C. H.	25
Cooper, T.	23
Moore, W.	23
Tooley, J.	22
Nickerson	21
Morely, A.	20
*Ansell	20
†Paynter	20
†Wood, F.	19
†Goodall	19
Kirby, A.	19
Corbett, G.	19
Payne	19
†Brewin	18
Thomas	18
Heatley	18
Armstrong	17
Farrant	17
Page	17
†Godrich	15
Simpkin	15
Anstey	14
Broadhurst	12
Waterfield	12
Moore, T.	11
Hunt	10

* Died in service.
† Resigned.

FIG. 3—GENERAL VIEW OF FOUNDRY BEFORE RECONSTRUCTION SHOWING OLD JIB CRANES WITH SOLID OAK POSTS

tain duplicates of such timbers today. These oak posts were practically everlasting, and when removed in June this year were as solid as when they had been installed, although some of the cranes, which had been built for the first foundry owned by the original William Richards, were about 70 years old. These cranes were fitted with their original mechanism, including a wrought-iron chain hoisting gear operated by hand through a drum fitted with a spur-gear reduction. Sometimes as many as eight men were called upon to man the cranks. A ⅝-inch hoisting chain was employed. These cranes had a radius of 21 feet and a height of 13 feet. They were fastened to bed plates in the floor and to the lower chords of the roof trusses at the top.

As Bill Would Say

While no one would want to go back to the old methods, it is well for the younger generation of foundrymen not to forget that castings fully the equal of any of those produced today were turned out in their fathers' shops—not occasionally but regularly, in spite of the wooden flasks, wooden cranes and other rather crude equipment with which they had to work. As Pat Dwyer's friend Bill might say: "Good castings come from the foundryman's brains, and not from electric juice, flossy paint and other fancy fixin's."

Nevertheless modern equipment more than justifies itself as an aid in turning out good castings regularly and cheaply. With wages from two to three times their prewar level, foundrymen are finding it necessary to place more and more reliance on mechanical aids to production, in order to stem the continually rising tide of costs. The firm of W. Richards &

FIG. 4—A VIEW FROM THE SAME POSITION AS IN FIG. 3 AFTER RECONSTRUCTION OPERATIONS WERE COMPLETED—NOTE DOUBLE CRANE RUNWAY

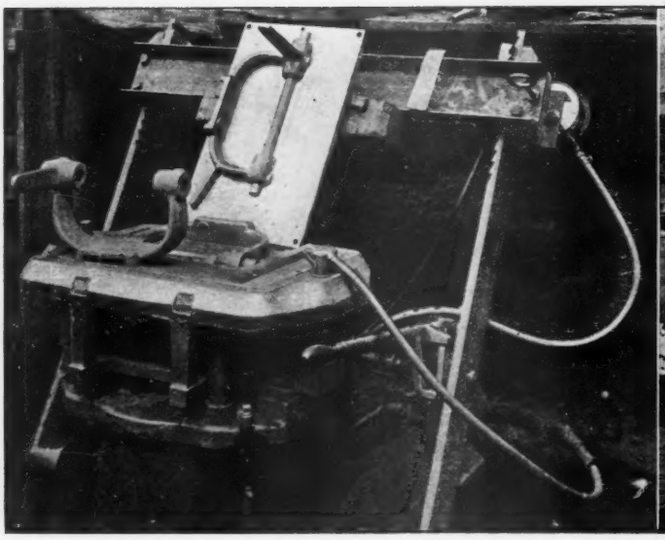

FIG. 5.—ONE OF THE AMERICAN SQUEEZER MACHINES RIGGED TO MAKE COUNTERSHAFT BRACKETS

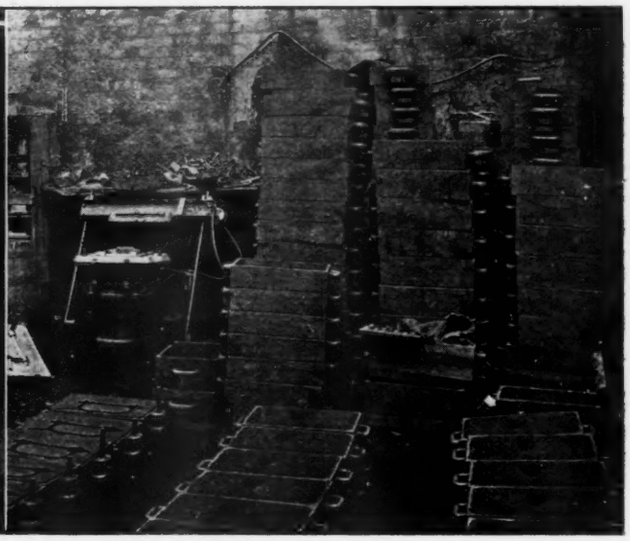

FIG. 6—PORTION OF A FLOOR OF COUNTERSHAFT-BRACKET MOLDS

Son is one of the most alert in England in utilizing modern foundry appliances, and the new rebuilt foundry at Leicester has been unusually completely equipped.

Included in the equipment of the new foundry is a battery of five combination squeezer and pattern-drawing machines furnished by the Tabor Mfg. Co., Philadelphia, through its British agents, Macnab & Co., London. These machines are used in the Richards foundry for molding a large variety of light castings on a quantity production basis.

A typical machine-molded job is illustrated in Figs. 5 and 6. These illustrations show a countershaft bracket mounted on a Tabor plain squeezer and pattern drawing machine. Air is supplied to the machine at 80 pounds per square inch pressure. A two part 12 x 19-inch cast-iron flask is employed, the drag being 6 inches and the cope 4½-inches deep. These flasks have ½-inch walls, solid cast-iron handles and are of unusually heavy and durable construction. The pattern is split axially, the cope and drag halves being each mounted on a heavy cast-iron pattern plate about ⅝-inch thick. These plates are unusually strong and substantial as their liberal thickness testifies. They are fastened to the table of the machine by machine screws through the four corners in the usual manner. The same machine in this case is used for molding both the copes and the drags, the plates being interchanged. Fig. 5 shows the machine fitted with the cope plate; the drag plate may be seen in the background leaning against the squeezer head. One of the finished castings is shown in this illustration. Fig. 6 shows a portion of the day's output, the group of drag molds at the left being ready to receive the copes as fast as they are rammed-up. This casting of course is quite simple and only one straight cylindrical core is necessary. Dry sand is used for the parting between the two halves of the molds.

England is well favored with widely distributed beds of high-grade foundry sands suitable both for molding and coremaking. In this case a satisfactory sand, which may be used in its natural state, after screening and milling, is obtained about two miles from Leicester. This sand contains suffcient natural bonding materials so that good cores can be made from it without the addition of oil or other artificial binders. The raw cores are simply mixed to a good wet consistency with plain water and baked. For stronger cores a half pint of oil may be used to a barrow of sand.

The muller in which the sand is prepared presents some peculiar features

FIG. 7—FINISHED DRILL-PRESS COLUMN, WITH PORTION OF CLEANING ROOM IN BACKGROUND

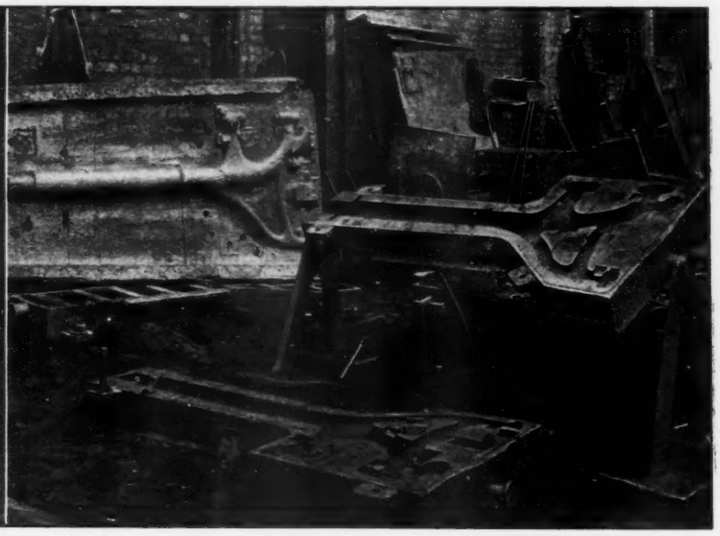

FIG. 8—THE DRILL-PRESS COLUMNS ARE MOLDED ON THE FLOOR IN SPECIALLY SHAPED FLASKS

from the American standpoint. It is illustrated in Fig. 1. It is motor driven and is of the customary stationary-pan type. The grinding wheels, however, are toothed as shown in the illustration; the teeth are about 3 inches deep and are set on a circumferential pitch of about 6 inches The wheels are approximately 30 inches in diameter, and the basin is 6 feet in diameter across the top. The prepared sand is discharged by a rotating plow through a chute into wheelbarrows in which it is transferred to the foundry floors. The sand storage bins, which are arranged alongside of the mixing machine, are filled from overhead, a track being so arranged that the sand may be dumped directly from the railway cars into the storage bins under-

FIG. 10—CORNER IN CORE-MOLDING DEPARTMENT —THE OVENS SHOWN IN THE REAR ARE HEATED BY OPEN FIREPLACES

FIG. 9—THE CUPOLAS, PLACED OUT OF DOORS, ARE THE SOLID-BOTTOM TYPE

neath. Included in the molding-room equipment are also machines built by the Adaptable Moulding Machine Co., Birmingham, England. These machines are of the stripping-plate type. They are carefully designed and strongly constructed, and possess the additional feature of being adjustable, by means of a small hand crank, to flasks of different sizes. A large jar-ramming machine is also being installed in the foundry.

Machine-tool castings are among the specialties of W. Richards & Son. On account of their size, they usually are molded on the floor. Figs. 7, 8 and 12 illustrate the method employed for making a drill press column—a typical machine-tool job. The casting weighs 268 pounds. It is made on the floor in a two part flask, using a split pattern mounted on a wooden pattern board as shown in Fig. 8. A cast-iron flask specially shaped to save sand is employed, and trunnion supports, shown in Fig. 8, have been provided to assist in rolling over the mold. The mold is gated at two points near the top of the column. The small wall cranes, which are fitted with hand operated chain hoists, are used for handling the flasks. The cores for these castings are made in halves and pasted together. They are rammed in wooden core boxes, on the floor, as shown in Fig. 12 careful attention being paid to the venting and rodding.

These, and the other larger cores, are baked in coke-fired, car-type ovens, shown in Fig. 10. Three of these ovens are located at one corner of

FIG. 11—A PORTION OF THE SMALL-CORE DEPARTMENT SHOWING SHELF OVENS

the molding floor. The car tracks are served by a jib crane for handling the heavy cores. These ovens also are used for drying molds when required. The arrangements for firing, although common enough in England, are quite novel from the American standpoint. Instead of the usual outside firebox with wall and floor flues for conducting the hot gases, the ovens are provided on the inside at the back with simple open fireplaces connected to ordinary straight chimneys. Suitable grates are fitted for holding the coke, the fuel being fired from inside the oven. One charge of fuel is sufficient, after the oven is warmed up, to bake a set of cores. There are no flues, or other complications, and the radiation from the walls and roof is depended upon to heat the oven in a sufficiently uniform manner.

For making small cores, the coreroom shown in Fig. 11 has been provided. It is thoroughly equipped in the usual manner with coremakers' benches, shelves and two coke-fired drying ovens of the shelf type. These ovens are shown at the left in Fig. 11.

Three cupolas are provided for melting the iron. The smallest one is used only for occasional special purposes, it being only 20 inches in diameter, inside, wth a capacty of about 1½ tons an hour. It is located apart from the two main cupolas, which are shown in Fig. 9. These large furnaces are located at one side of the foundry, near the middle. They are separated from the molding room by a wall through which only the spouts project. This keeps the nuisances incident to cupola operation out of the foundry.

The two larger cupolas are approximately 38 and 42 inches inside diameter respectively, their melting capacities being respectively about four and five tons an hour. The blast is furnished by a motor-driven No. 5 Roots blower built by Thwaites Bros. Ltd., Bradford, England. The cupolas were built on the premises. They are of the English solid-bottom type, the refuse from the heat being raked out through a door provided at the rear. A windbox surrounds the melting zone and the air is led into the cupola through two rows of trumpet shaped tuyeres, with 5-inch outlets and 4-inch inlets, approximately. There are four tuyeres in each row.

Advantage is taken of the mild English climate to place the melting furnaces virtually out of doors. The charging platform, which is of the usual steel construction, has neither roof nor walls. It is reached by an inclined runway on which the charges are hauled up from the stockyard.

The hot metal is handled in the foundry either by the traveling cranes or on small trucks. The trucks run on a narrow-gauge track which extends through the shop. Complete ladle equipment ranging down from six tons capacity to the hand ladle is provided.

Mr. Richards and his son have given considerable thought to provisions for the comfort and well-being of the workmen. Suitable conveniences of the usual character are provided, and the liberal policies pursued in this respect are reflected in the low labor turnover. Some of the men have been continuously in the employ of W. Richards & Son for nearly fifty years, and an unusually large proportion have records ranging from 15 to 30 years.

FIG. 9—THE LARGE CORES, SUCH AS FOR THE DRILL-PRESS CASTINGS ARE MOLDED ON THE FLOOR—THE CORE SAND HAS A NATURAL BOND

To Build Foundry

Reports to the department of commerce tell of the proposal of the Victorian railways in Australia to build a new foundry and electric furnace plant at Newport, Australia, for which $216,500 has been appropriated. This will supplant the present 30-year-old foundry at Newport and will cover an area of 46,700 square feet. Inquiries concerning equipment, and a proposal to begin construction of the consolidated type of locomotives will be answered by the secretary of the Victorian railways commission, Melbourne, Australia.

The S. Obermayer Co., Chicago, manufacturer of foundry supplies, recently has opened an office and warehouse at Blanchard and Ferry streets, Newark, N. J. This office will handle the export business of the company in addition to caring for the eastern territory. H. E. Beckman is in charge.

The National Engineering Co., Chicago has removed its New York office from 15 East Fortieth street to 248 Fulton street. S. H. Cleland is New York sales manager.

Safety Work Must Be Well Planned

Committees Should Be Organized Under the Direction of a Safety Engineer—A Workmen's Committee Serves to Educate the Shop Employes if the Membership Is Changed Frequently

BY R. A. SALISBURY

THE attitude of the executive toward safety is reflected in the organization he perfects to prevent accidents. Dividing accident prevention work into three divisions, namely: Organization, entailing the formation of safety committees; education, covering methods of enlightening the employe on the value of safety; and safeguarding, including mechanical devices and appliances, lighting and sanitation; it is apparent organization is of prime importance. It is the center from which education and safeguarding emanate.

Organization may assume various forms. It may be as varied as the conditions are varied in the plants where it is to be applied, and each safety engineer may have a favorite plan. The special topic to which attention is given in this paper is the general plan of organization best suited to accident prevention work in a foundry divided into a chilled-wheel and soft shop where there are from 1000 to 1200 men employed.

The ideal method of organization must include employe, as well as officer and the various units of such organization must have highly specialized functions. There must also be co-operation between the various units and one of such units must stand in the position of a court of review to which any disputed matter may be appealed for final decision. The unit of the safety organization, as it is indeed the unit of all social organization for whatever purpose it may exist, is the committee. The number of committees may be large or small, but the author's own view is that five committees in the foundry are sufficient to carry on the work. Too many units are necessarily cumbersome and may result in overlapping activities. The five committees, each of which is briefly discussed here may be conveniently designated as the plant committee, foremen's committee, workmen's committee, accident investigation committee and a special chain and cable committee.

The manager or general superintendent of the shop should act as chairman of committee which ought to include the general foreman, master mechanic, chief engineer, local auditor and safety engineer. The latter should act as secretary and hold himself responsible for the general functioning of the committee.

This unit ought to meet regularly at least once a month and whenever a special occasion demands attention. It should pass upon all recommendations which have been appealed to it from other committees, and discuss suggestions from individual employes or from the other committees, with a view to ascertaining whether they are feasible or practicable. This committee should arbitrate and finally pass upon all matters submitted to it and formulate all rules, regulations and specifications. It must also supervise all matters pertaining to safety education, special report forms and service work.

Foremen's Committee

The foremen's committee, as the name indicates, must include in its membership the foremen of the shop. Their meetings should be semimonthly. At these meetings, special attention should be given to the discussion of accidents which have occurred in the shop with a special view to reaching clear-cut conclusions as to their cause. Of equal importance to ascertaining the cause of accidents is the discussion of ways and means to prevent their recurrence, and this, of course, is the most important work of the foremen's committee. This committee should also receive comparative accident reports. The safety engineer should make it his duty to examine the members of the committee on general safety rules at least once a month. Inspection tours of the shop should be frequently made by the members of the foremen's committee. The safety engineer should prepare a simple set of by-laws and see to it that all the members of the committee abide by the rules and regulations contained in such by-laws. Carelessness or negligence in attending meetings should be discouraged and absence from a meeting duly called by the safety engineer should be noted in the minutes of the meeting and a written excuse required from the member who is derelict.

The workmen's committee is composed of representatives of the workmen of the plant. Such representatives may either be chosen by the foreman over each department, or by the foreman in conjunction with the workmen. In a plant of the size we are now discussing there should be seven representative molders, four cupola men, two brake-wheel workmen, two core-room employes, one wheel-pit worker, two yardmen, three chipping-wheel employes, three shop laborers, one teamster, two machine-shop men, one pattern-shop employe, one representative of the electricians and two miscellaneous employes. Of course, the committee will have among its representatives both day and shift workers. The day workers and the shift workers should serve on the committee two months and the two sets should be appointed on alternate months to obviate changing the entire personnel of the committee at one time. This committee ought to meet semimonthly upon due notice given by the safety engineer who should also act as chairman.

The safety engineer should see to it that all current accidents are thoroughly discussed and that suggestions for the prevention of similar occurrences have the fullest consideration by the members of the committee. In many respects, the workmen's committee is the most important unit of the organization, and the safety engineer will find that he will have the best opportunity of inculcating and disseminating ideas of safety through this committee. By reason of the changing membership of the committee all of the employes in the shop will in time become educated in safety work. It goes without saying that these meetings should be held on the company's time.

The accident investigating committee must have for its membership the best intelligence in the office. The master mechanic should act as chairman and the chief electrician, carpenter-shop foreman and safety engineer should serve with him. The committee should inspect all circumstances surrounding an accident in a thorough and impartial manner, with a view to ascertaining the immediate as well as remote causes for the accident. Forms promulgated by the safety engineer

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Paper prepared for the Milwaukee meeting of the National Safety council, Sept. 27 to Oct. 1, 1920, by R. A. Salisbury, Interlake Iron & Steel Co., Chicago.

should be used by this committee in making reports of accidents. The safety engineer should see to it that these reports are complete in detail, bearing in mind that it may be necessary to submit such reports to the law department in case of a controversy between the employer and the employe. In its sittings this committee should be careful not to rely upon hearsay and rumor as to the circumstances surrounding the accident, but should call before it the actual eye-witnesses and obtain from them the desired information.

The master mechanic should appoint two riggers to act as the chain and cable committee, which ought to hold meetings at least once a week. These men should be instructed to make a thorough survey of the plant with a particular view to inspecting chains, cables, hooks, ropes and blocks and tackle. It should be their duty to report their findings on the condition of the equipment to the safety department at once. In case a piece of equipment is found to be dangerously defective this committee should have authority to immediately tag it *out of order.*

Accident Records

The safety department should be able to justify its existence by referring the doubter to records and statistics. Records of all accidents must be retained. In classifying accidents, causes are unquestionably of paramount importance to the safety engineer. These should engage his best attention and furnish him constantly with new ideas of accident prevention. The effort put forth by a safety engineer in the mental process of generalizing from the recorded causes of accidents will abundantly repay him. Records should also be classified as to time lost.

The initial step in the preparation of records is the foreman's report of the accident. This may be made on a stereotype form in such a manner that a mere glance will inform the examiner the date of the accident; a brief description thereof; the nature of the work in which the employe was engaged at the exact moment of the accident; and his experience at the work in which he was engaged at the time of the accident. The records will necessarily include a technical report by the surgical department. From all of these initial reports the engineer must decide upon the nature and extent of the investigation that will be required. The engineer should compile at regular intervals reports of accidents calculated to clearly indicate their cause, and these reports should be posted on all bulletin boards and furnish the themes of the discussion at safety meetings. The records must also show cost of accidents both to the employer and employe. The safety department must make cost reports showing the monthly expense and disbursements of the department, and at the same time indicate the increase or decrease from the corresponding period of the previous year or years. The reports should suggest reasons for the increase or diminution of the expenses of the department. The cost and expense of the safety department should be classified in hospital fees, medical and surgical expense, salaries, amounts paid in settling claims, amounts paid on pending claims and estimates to be paid.

Bulletin boards of sufficient number to display the material sent from the National Safety council should be well placed. In addition to the ordinary bulletin boards, a large board 15 feet by 20 feet, portraying a page of a calendar should be placed at each of the main gates. Each accident resulting in disability of seven or more days duration should be indicated on this board by a red line drawn through the numerals, and fatalities should be recorded by a blue line. Space should be provided on this board for striking phrases and pointed sentences which may be frequently changed. Interest in this board must be stimulated by interrogation of workmen picked at random from the plant. On these occasions the employe is examined as to his recollection of the material facts appearing on the board, and at the same time inquiries can be made as to whether he possesses goggles and a rule book. In each case he should be encouraged in suggesting means of accident prevention. We have found that this method of personal examination brings gratifying results. Much also can be made of danger and caution signs, of moving picture exhibitions, and of systems of awards or bonuses for favorable accident records.

Pouring Stacked Molds

Question: We are greatly pressed for room in our foundry and would appreciate any information you might give us on this subject. We have frequently seen illustrations in THE FOUNDRY showing snap flask molds stacked on top of each other. It is not clear to us the manner in which these molds are poured; but apparently some one has solved the problem and we should like to adopt the same system.

Answer: The method briefly may be divided into two general classes. The first is confined to snap flasks in which part of the pattern is in the cope or where there is an irregular parting and also where the runner is located close to one side or one end of the flask. In such cases, the lower row of molds is made first. When placing the next row on top the flasks are not piled directly on top of each other with the four corners coinciding. The flasks in the top row are kept back just far enough to expose the opening of the pouring sprue in the flasks beneath. The lower layer of molds is poured first to prevent any splashes of metal from falling into the open runners, which might happen if the top row was poured first.

The second method is confined to flasks with flat copes and in this case they are stacked from four to ten high. Properly speaking there is no cope employed in this method owing to the fact that the bottom face of each drag forms the cope face of the preceding mold. A continuous upright runner extends from the top to the bottom. The bottom drag rests on a board and the hole provided for a runner is, in this particular drag, plugged at the level of the horizontal gates.

This method generally is confined to an arrangement of patterns which permits the runner to be placed in the center of the flask. Flat iron bands which fit snugly inside the snap flask are rammed up with the mold and are designed to prevent the lower molds from bursting from the static pressure of the iron. Slip jackets of course may be used for the same purpose but they do not always fit closely.

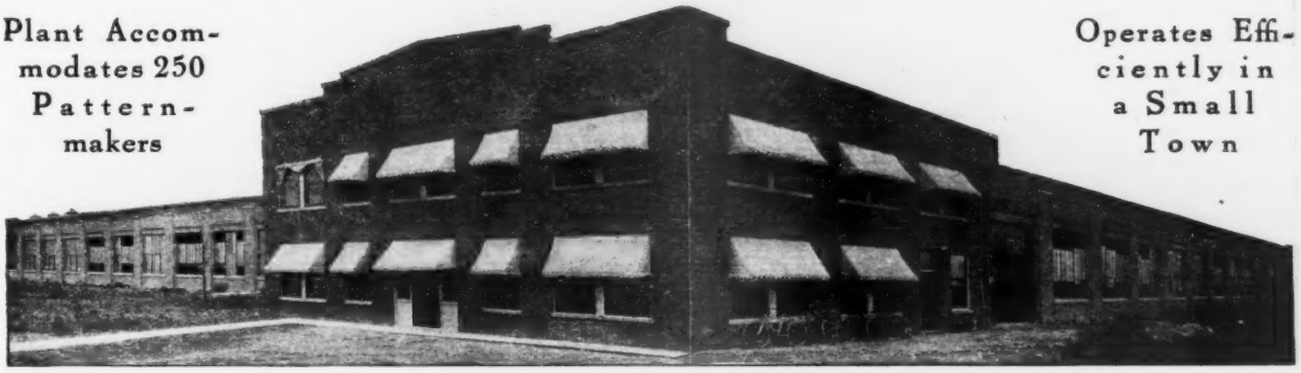
Increase Capital to Purchase Equipment

Corporation Pattern Works, Inc., Rochester, N. Y., according to George J. Pink, manager, recently increased its capital stock from $5000 to $25,000, as a means of increasing its working capital, made necessary by the increase in its business, as well as to finance the purchase of new equipment. The new equipment will include machine shop equipment, as well as equipment for the wood and metal pattern departments. In addition the company will install the necessary equipment for the casting of aluminum and brass castings.

Sandiver is the name of a flux used in brass melting. It is a by-product of glass manufacture, simply the skimmings of the pots. It is supposed to remove iron from melted brass, silver and other nonferrous metals. It can be imitated very easily as follows: Sea or other sharp sand, 2 parts; soda ash, 1 part; the latter mixture is also known as *ironfiend.*

Rehabilitate Shop in Record Time

Plant Accommodates 250 Patternmakers



Operates Efficiently in a Small Town

The pattern shop usually is regarded as an accessory to or necessary part of any manufacturing plant engaged in producing castings for machinery.

The cost of making patterns is apportion in various ways depending on the size of the plant and the individual views of the owner. It ranges from the simple system whereby the total pattern shop expense is lumped together and charged to general expenses, to the highly specialized and itemized method which shows how every minute of a man's time and every nail and screw is accounted for and entered as a direct charge against each individual pattern.

The pattern shop generally is situated close to the foundry and furnishes employment for approximately one-third as many men as the total number of molders engaged. In some places, particularly large cities or great foundry centers, pattern shops are operated as independent manufacturing plants. These take orders for patterns in the same way as the manufacturers of any other commodity. Some are prepared to handle patterns of diversified size and shape, while others confine themselves to the special line of castings produced in their immediate neighborhood. This is particularly true of the independent pattern shops catering to the automobile and machine tool trades.

No Foundry Near

In the quiet town of Bryan in the northwestern corner of Ohio, 57 miles from Toledo, is located one of the largest and most completely equipped plants in the country devoted exclusively to the manufacture of patterns. There is no foundry in Bryan and, therefore, it is apparent that the shop of the Bryan Pattern & Machine Co., was not built to cater to local trade. This fact is further supported by its order book which discloses orders from the foundries scattered all over the territory from the Canadian border to the Ohio river and extending from Chicago to the Atlantic sea board.

The diversified character of the work handled at the plant reflects the immense and widely scattered clientel from whom the orders are received. Patterns are made in wood, iron, brass, aluminum, white metal and plaster and vary in size from a toy that would go in the vest pocket to immense jobs that are only limited in size by the clearance and the height of the bridges under which they are carried by the railroad cars to their destination.

The present brick and steel building construction is practicaly new having only been in use since April 1920. It replaces the former building which was destroyed by fire on Nov. 2, 1919. The manner in which this loss was met, production kept up and a better

FIG. 1—GENERAL VIEW OF WING DEVOTED TO THE MAKING OF METAL PATTERNS—THE FOUNDRY IS LOCATED AT THE FAR END AND IS PARTITIONED OFF BY A BRICK WALL

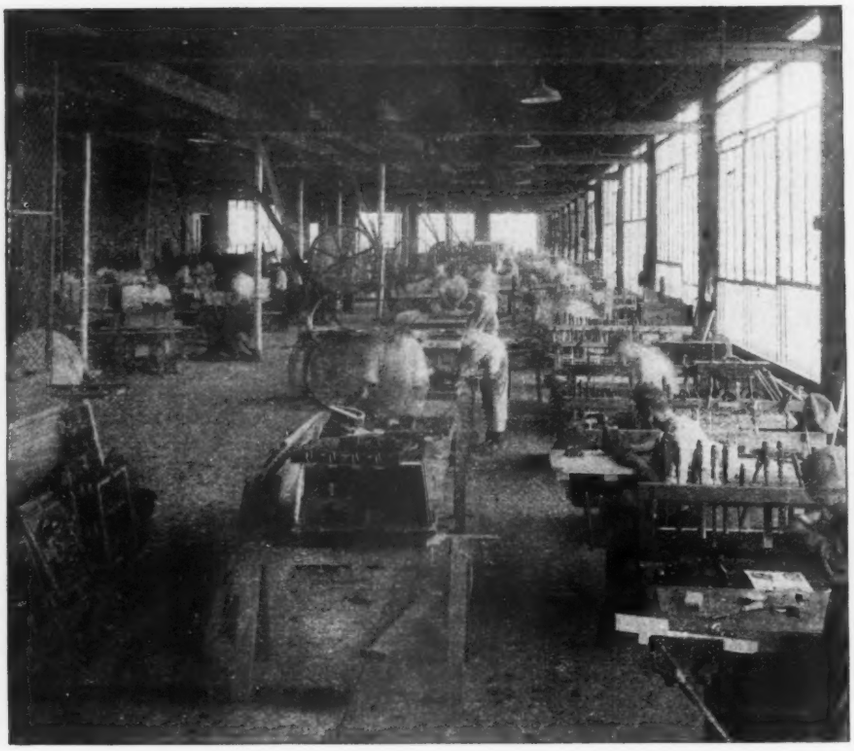


FIG. 2—IN THE WOODEN-PATTERN SHOP—THE CORNER OF THE WIRE SCREEN INCLOSING THE STOREROOM IS SHOWN ON THE EXTREME LEFT—THE POWER MACHINES ARE EQUIPPED WITH SAFETY GUARDS AND DUST COLLECTORS

and larger shop rushed to completion under adverse labor and material conditions furnishes an interesting commentary on the charter of the organization and also explains to a considerable degree the sucess which has attended the enterprise since its inaugeration.

Fire from an unkown cause was discovered early one Sunday morning. It then had progressed so that nothingcould be done and when L.M. McDonald, vice president and general manager, who had been hasitly summond from Wauseon about 20 miles away, arrived, the building and contents including the wooden parts of the machinery, patternmakers tools and 34 crates of finished patterns were reduced to ashes.

Quick Recovery

He called his men together, asked them to stand by and promised to have them all at work in a day or two. He sent a truck to Toledo with directions to collect all available patternmaker's tools in the city and bring them back. Instructions were telegraphed to Chicago to ship immediately by truck a supply of pattern lumber. Arrangements were made with half a dozen owners of available space in all kind of places from an empty garage to the second floor of a show case factory and as many men were crowded in as the space would permit. Architects were called into conference and plans were approed at once for a new shop to be erected and equipped.

The only thing saved out of the fire was the safe containing the office records. From the information therein contained it was possibile to lay out some of the work and incredible as it may seem the first pattern was completed at 4 p.m. on Monday, the day following the fire. From that time production increased steadily until the new shop was finished on the first of April and the various gangs of men who had been scattered all over the town were once more grouped under one roof. The organization was held together, duplicate patterns made for those destroyed in the fire, old customers were taken care of and an aggressive campaign carried on for new business.

Consider Three Methods

Past experience was drawn upon in building the new plant having carefully considered the three usual plans for erecting buildings of an industrial character, viz; the cost plus plan; the flat price plan and the straight day labor under intelligent supervision plan. The latter was adopted. Workmen were hired and material secured whenever and wherever possible and if necessary at a premium. The progress of the work was considerably handicapped by the congested transportation conditions which obtained during the winter of 1919-20 and also by the failure of some of the supply men to furnish material at the time specified.

Overcoming these handicaps the building was finished, machinery installed and the first pattern turned out on April 1, 1920. Many of the machines, particularly those employed in the metal pattern making department of the former plant were salvaged from the fire, repaired, set up and placed in operation in the new shop.

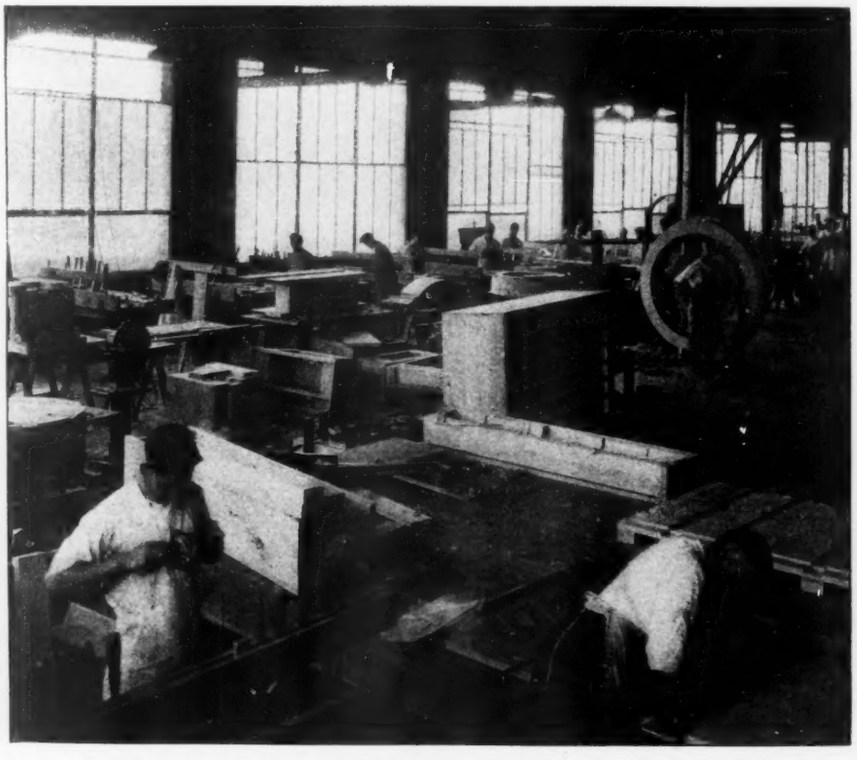


FIG. 3—ANOTHER VIEW OF THE WOODEN-PATTERN SHOP TAKEN FROM THE OPPOSITE END TO THAT SHOWN IN FIG. 2

The general features of the exterior of the building are plainly evident from the illustration at the top of the first page. It is built in the form of a 1-story L-wing measuring 60 x 200 feet. The office is situated at the junction of the two wings and is a two story structure, the lower floor devoted to the offices of the executive and clerical force and the upper to the engineering department comprising draftsmen, estimators and pattern-mounting experts whose advice is available for prospective customers. Several additions are attached to the interior wall back of the right wing. One of these rooms is used as a pattern lumber storage, one for a locker and wash room. Plaster patterns are made exclusively in a third, a fourth is devoted to a boiler and heating equipment and a fifth room is fitted up in a special manner for painting the patterns.

Electric Lighting System

Light and ventilation are provided through steel sash each unit of which is divided into two parts and hung by counterweighted cords so that one half may be shoved up and the other half pulled down. A soft, diffused, yet strong and clear light filters through the corrugated frosted window panes of the sash.

Artificial lighting is provided by a battery of 500-watt, gas filled Mazda lamps hung under enameled steel reflectors which distribute the light evenly with practically no shadows. The electric current for light and power is brought in over a heavy-duty line from the power house of the Toledo & Indiana railroad. It comes in at 13,000 volts and is stepped down to 440 volts at 25 cycles, 3 phases for the machine tools and to 110 vots for the lights and portable motors. The transformers are situated in the angle of the L formed by the two wings of the building. The space is partly covered by the rooms already mentioned, the pattern lumber storage, the boilder room, wash room, etc., and in the corner of the square diagonally back of the office, an oil tank with a capacity of 10,000 gallons is buried under ground. The oil is used for melting the metal in the metal pattern making department of the plant.

FIG. 5—THE OIL-FIRED, TILTING FURNACES ARE LOCATED IN THE EXTREME END OF THE METAL PATTERN MAKING DEPARTMENT AND SEPARATED FROM THE MOLDING FLOOR BY A BRICK WALL

FIG. 4—SMALL PORTABLE BENCHES IN THE FOUNDRY ARE A FACTOR IN AIDING FLEXIBILITY OF OPERATION—THERE ARE NO ARBITRARY FLOORS

Sprinkler System Installed

The building is practically fireproof, the only inflammable material being in the office partitions and furniture, the patternmaker's benches and the inlaid wooden floor on both sides of the shop. Six 4 x 8 southern pine beams rest on the steel I-beams supporting the roof and to these wooden beams the bearings for the shafting are attached. A steel frame supports a roof made of matched lumber and covered with a coating of gravel and asphalt. Perforated pipes suspended 6 inches from the roof and located 4 feet apart, with the perforations pointing upward and at an angle, are connected to the town water supply. They are capable of dashing a solid sheet of water over every inch of the roof interior.

Concrete floors are laid throughout the entire building, including the office. The floor has been checked down for about an inch in depth for a

space 10 feet wide on each side of the building where the benches are located and a wooden floor is inlaid. It is claimed that wooden floors are easier on the feet than any other kind.

A room 30x30 feet, opening off the wooden pattern shop, has been fitted for the convenience of the employes. Wire lockers in which the men may keep their change of clothing are attached to the wall all around. A double row of wash basins supplied with hot and cold water extends across the center of the floor for a distance of about 20 feet, and a half dozen showers are provided in one corner of the room. All the water used in the shop comes from an artesian well situated on the premises of the company and supplied under pressure by an electrically operated pump. Immediately back of the bath room the apparatus for heating the shop is located. The equipment was supplied by the American Radiator Co. and comprises two furnaces together with the necessary piping and connections for heating the building on the vacuum system.

A large bin located close beside the furnaces forms a receptacle for all the shavings and sawdust that are piped from the different wood working machines by a suction fan. Shavings from the benches, and all other waste pieces of wood are gathered up in a wheelbarrow and also deposited in the same bin. During the summer this material is baled and stored outside; but in winter it will be used as fast as it accumulates. The pattern lumber is stored in the room shown in Fig. 7. It is taken directly from the cars which come in on a railroad spur from the New York Central railroad which passes close by the property line of the company. This spur or siding also serves as a convenience for loading large patterns and crates of small patterns directly on the cars. In addition to the New York Central railroad the town is also served by the Lake Erie & Western and the Cincinnati Northern railroads. In fact the unusual railroad facilities was one of the reasons why the company selected Bryan rather than one of the other towns in the same territory in which to build the factory.

Interior views of the wood pattern-making department are shown in Figs. 2 and 3. A general view of the metal-pattern finishing department is shown in Fig. 1. It will be noted in both instances that the layout is the same. The work benches are situated close to the wall on both sides and in the case of the wood-working department there also is a row of benches across one end. The power tools are located on each side of a central gangway and are driven from countershafts which in turn receive their power from a central main shaft divided in the center into two sections. One section under which the heavier tools are grouped is driven by a 25-horsepower Westinghouse motor while a 15-horsepower motor furnishes the power for the remaining section. In addition to the stationary power tools there are many electrically operated portable tools provided including the glue pots which are heated by electric current.

A brick wall separates the foundry at one end from the metal pattern-making department. The foundry is further sub-divided by another brick wall into two departments, the molding floor and the melting room. Light, heat, ventilation and building features are the same as in other parts of the building. This foundry differs in many ways from the regular commercial shop. Accuracy and quality in the castings are the prime considerations, rather than speed and quantity. It will be apparent from the illustration, Fig. 4, that there is no crowding and no effort made for quantity production. Each job is handled individually by a highly skilled molder familiar with the peculiarities of iron, brass, white metal or aluminum.

In addition to making castings for patterns and match-plates from any of these metals, the company is prepared to furnish sample castings from any of the patterns after they are finished. The melting equipment comprises two open-flame oil-fired tilting furnaces made by the Monarch Engineering Co., Baltimore, Md., each having a capacity of 500 pounds of nonferrous metal, and one crucible pit furnace made by the White-Downing Mfg. Co., Cleveland. One of the tilting furnaces is employed to melt cast iron when it is necessary to pour an iron casting and heats up to 400 pounds have been handled successfully. The charge is made up exclusively of charcoal pig iron broken into small pieces. Gates and sprues from former castings are added to the charge but the amount is so small as to be negligible.

Patternmaking does not lend itself readily or to any extent to standardization. Each pattern is a little different from any other and it is therefore impossible to get out stock and put them through in hundred or thousand lots. The nearest approach that can be made to standardizing the work is to classify it by groups and distribute it by this classification among the men. By constantly handling the same general class of work each group develops speed and accuracy far in excess of the man who is called on to handle a different class of work every day. However, one job that has been standardized is that of painting the patterns.

Instead of each man painting his pattern after it is complete as in ordinary pattern shop practice, the patterns made in this shop are all painted by one man in a special room set apart and fitted up for that pur-

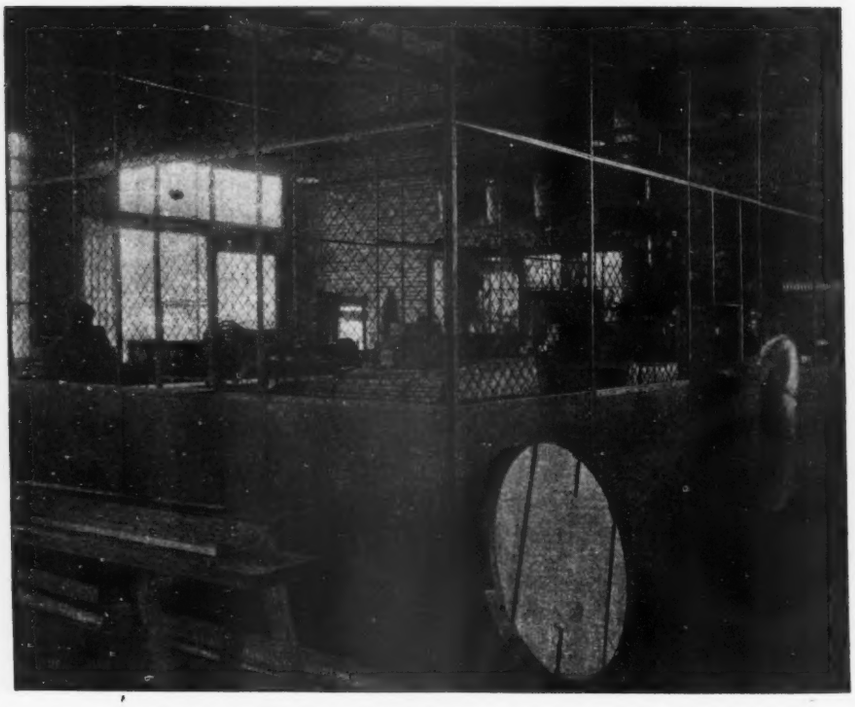


FIG. 6—THE COMBINED STOREROOM, REPAIR SHOP AND TOOL CRIB IS LOCATED INSIDE THE BUILDING AT THE APEX OF THE ANGLE FORMED BY THE TWO WINGS

pose. A small air compressor, pressure tank and spraying device made by the DeVilbis Mfg. Co., Toledo, O., is employed for depositing the shellac varnish on the patterns which are supported upon an empty tank into which the surplus varnish drains and is afterward collected for further use.

A wire enclosure is provided for the checkers and inspectors. The door of this room is kept locked and can be opened only from the inside. When the patterns leave this room for the last time they are supposed to be absolutely accurate and the most intense concentration is essential on the part of the checker and inspector to insure this result. The chance of errors being overlooked is greatly magnified if the inspector is interrupted during his examination. Special men are detailed for this duty. The room is equipped with surface tables and also the necessary tools and instruments for testing precision and accuracy.

The store room shown in Fig. 6 is located inside the end of the woodworking department which adjoins the metal section. In other words it is at the angle of the L and is therefore equally accessible from either department. Tools and supplies of every conceivable description with the exception of lumber and metal, which enter into the construction of patterns are kept here under the charge of a storekeeper. Besides handing out tools and materials he also keeps a perpetual inventory and stock list and one of his principal duties is to see that his supply of any item on hand does not drop below a certain predetermined point.

Check System Is Used

When a new patternmaker starts to work he is given a number of tools which are everywhere regarded as shop property and not supposed to be carried around by the patternmaker in his tool box. The value of the tools is charged against him and deducted from his pay when leaving the employment of the company if he fails to return them or fails to furnish a satisfactory explanation why he is unable to do so. He also is given a quantity of brass discs with his number stamped thereon. Each time he goes to the store room to borrow a tool, he leaves one of these disks. The store keeper hands him the tool and places the disk in the vacant space. When the man returns the tool he receives his disk again. Miscellaneous materials used in the construction of patterns is furnished on requisitions signed by the foreman.

One corner of the store room is set apart as a repair shop and tool room. The band saws all are filed here on a power-driven filing machine which automatically advances the saw one tooth at a time and draws a file across it. Facilities also are available for brazing the saws after they have broken. The drills are ground by an expert and the knives of planers kept in keen cutting order. Spare parts for all the power tools or such parts as occasionally need replacement are kept in stock and are immediately available in case they are needed at any time.

FIG. 7—THE MAN IN CHARGE OF THE LUMBER STORAGE GETS OUT THE APPROXIMATE AMOUNT OF LUMBER FOR EACH REQUISITION IN THE MOST ECONOMICAL MANNER

While the company is prepared to furnish any kind of a pattern made from any kind of material and to accept payment on any satisfactory basis, still the great bulk of its business is contracted for at a definite price. This is believed to be the most satisfactory method both from the customers and the manufacturer's standpoint. When an inquiry is received it is referred to an estimator who calculates the number of hours and feet of material required to complete it. Based on this estimate a flat price is quoted the customer and if accepted work is commenced on the job. The original estimate is kept on file and by a system of records progress report is kept on the job until it is finished.

At first glance one might be tempted to think that this method would be taken advantage of by the men, if it showed promise of coming out under the estimated time. Even if such were the case the company would not lose by it because the original estimate provided for a profit on that basis. However, this feature is guarded against by confining this knowledge to the estimator, the superintendent and the foremen. The foreman's prestige and value to the company depends on keeping all jobs inside the estimate, which is incentive enough to keep him busy. The individual patternmaker does not know when he starts a job how long it is going to take to finish it; but if he exceeds the estimated time he is promptly told by the foreman that he is too slow for that company and if he falls down a second time he is paid off.

Supply Company Builds New Plant

The Federal Foundry Supply Co., Cleveland, is constructing an extensive sea-coal mill in Charleroi, Pa, This plant is located adjacent to the coal tipple of the Youghiogheny & Ohio Co. Coal will be delivered directly to the bin supplying the sea-coal mills. This delivery from the mine cars eliminates delay incident to awaiting empty coal cars also saves expense in handling. The mine has river and rail connections and is operated six days a week. The plant of the Federal Co. will have a capacity of 150 tons per day, and it is anticipated that empty box cars for shipment of this material may be obtained without difficulty.

The machinery which has been installed is specially designed for this work and it is stated gives material which is uniform and granular in shape, and with a minimum of waste. The plant will be in operation by Jan. 1.

Correcting Flaws in Metals and Mixes

Problems of the Gray-iron, Malleable and Steel Foundry Discussed

By H. E. Diller

Low-Silicon Iron for Balls in Grinding Mills

Question—Please advise us from what grade of metal chilled-iron balls, 1¼ to 6 inches in diameter, for grinding mills should be made.

Answer—Such balls are not usually made from chilled iron, but are made of a low-silicon iron of approximately the same composition as the hard iron for malleable castings. This gives a white metal and is found entirely satisfactory for the work. It is of the following composition: Silicon, 0.40 to 1.00 per cent; sulphur, below 0.07 per cent if air-furnace iron is used, or below 0.12 per cent if cupola metal is used; phosphorus, between 0.15 and 0.20 per cent; manganese, between 0.20 and 0.30 per cent; and total carbon, between 2.50 and 3.40 per cent. In air-furnace iron the carbon will be lower than in cupola iron. Metal with the lower limit of silicon is cast into the larger balls while the higher silicon metal is poured into the smaller ones.

If you do not have enough tonnage to cast the different sized balls from different metal it would be advisable to chill the larger balls instead of casting all the balls from metal with the lowest silicon contents. You might also make the larger size balls one day and the smaller balls the next to secure enough tonnage for any one composition of metal.

Metal for Gear Blanks

Question—We would like to know what metal to put in gear blanks weighing 50 to 250 pounds; that is, what should we put in the cupola and what physical properties should the metal have?

Answer—The gear blanks which you refer to should be made out of cupola iron in which 10 to 20 per cent of steel is mixed. Such a mixture is generally called semisteel. The metal should contain not more than 0.12 per cent sulphur, not more than 0.5 per cent phosphorus, and 0.5 to 0.8 per cent manganese. The silicon will vary according to the section of the castings but we should judge it should be 1.50 to 1.75 per cent. However, if you would send us a blueprint of the blank, we would be able to advise you more definitely in regard to the silicon content for the metal.

This metal should be of such a strength that arbitration bars, as adopted by the American Foundrymen's association and the American Society for Testing Materials, made from this metal, would have a transverse strength of not less than 3600 pounds and a tensile strength of not less than 30,000 pounds per square inch. While both transverse and tensile strength should be specified, the tensile test is not usually made on all bars. Test bars should be poured from the metal at the time the castings are made and one set of bars should be submitted for test.

Action of Copper-Aluminum Alloy on Iron

Question.—I understand that there is an alloy of copper and aluminum which when added to molten iron will give the metal a close grain and a low coefficient of expansion. Will you kindly advise me the proportions of each metal in the alloy?

Answer.—We have never heard of such an alloy and doubt whether any alloy of copper and aluminum would produce the results which you mention. Aluminum is sometimes added to cast iron either to soften it by increasing the proportion of graphitic carbon to combined carbon or to increase the electrical resistance of the iron. In the latter case aluminum is added in quantities up to 5 per cent. We know of no way copper would improve cast iron and therefore do not see how an alloy of the two metals could be used for the purpose you indicate, especially as aluminum would have a tendency to open the grain instead of closing it.

Preventing Defective Castings

Question—We are sending you a piston made in our foundry. The head has been broken off to try to find the cause for the metal not joining at the place marked. It appears to us that the trouble is caused by dirty iron. Is this surmise correct?

Answer—The casting appears as though the flaw was caused by cold iron, although so much machine work has been done on the casting that we are not able to determine this definitely. It is possible that the check may have been due to dirty iron. To avoid the difficulty the iron should be poured as hot as possible and strain gates should be used. A circular strainer core made of core sand should be placed in the runner or at the bottom of the pouring gate. A metal skim gate made of tin plate should be placed over the opening of the pouring gate. This will serve to hold the metal in the pouring basin long enough for a slight reservoir to form. Slag, which floats on top of the metal in this reservoir will be prevented from entering the mold if the head is maintained by keeping the pouring basin filled. Care also should be taken to see that the metal is well skimmed before being poured. It is a good plan to throw a few handfulls of sand on the metal after the bulk of the slag from the cupola has been skimmed off. This will collect the smaller particles of slag floating on the metal.

Malleable Not Recommended for Bearings

Question—I am figuring on a new form of axle boxing for a mine car for which cast iron would hardly be satisfactory owing to its tendency to fracture easily. Cast steel is more expensive and is too nearly the same degree of hardness as the axle to make a good bearing. Will you please state the nature of malleable iron and whether it would serve for this purpose.

Answer—Malleable iron is a grade of cast iron. It is hard as first cast and the carbon is all in the combined state. Later it is annealed. This anneal changes the carbon from the combined state, which makes the metal hard, to the soft, free, temper carbon, and causes the iron to become malleable. The temper carbon is in a different form from the graphite found in gray iron, being in small amorphous particles instead of in large flakes. For this reason it does not have as good lubricating qualities as does gray iron. Therefore in this respect a malleable-iron bearing would not give as good service as one of gray iron. The danger of breakage could possibly be sufficiently reduced by designing a heavier gray-iron bearing.

Training Executives for Foundries

Leadership Which Is Based Upon Character and Developed Through Knowledge Is Necessary in Organization—Technical School Aids in Preparing Administrative Officers

BY BRUCE W. BENEDICT AND ROBERT E. KENNEDY

THREE elements compose the foundry industry in its broad outlines: Recorded knowledge of the foundry art; the human organization, by which this knowledge is translated into usetul work; and the mechanical facilities of production. Although these elements are of fundamental importance, the second, or the human organization, outranks the others in vital character. If the recorded experience of the foundry art were eliminated at one sweep, much of it would remain in the minds of men, and beyond a pause for readjustment, production would go on as before. We can foresee that out of this wreck the fundamentals would emerge intact, since during the course of time they have become an integral part of thought and habit. And likewise, if the mechanical tools of production were suddenly wiped out of existence, men immediately would begin the construction of other facilities—doubtless of greater usefulness and efficiency, being less hampered by traditional restrictions. On the other hand these opportunities for reconstruction would not exist should it become necessary completely to replace the entire foundry organization. Its physical form might be duplicated without difficulty, but after replacing man for man the organization would be little more than a hollow shell. Grant it the will to work and the necessary intelligence, still it would lack the ability to function. Weeks and months would not serve to replace the knowledge and skill laboriously and painstakingly accumulated by foundrymen throughout successive generations. Instead of a temporary pause for reconstruction, there would be a long period of inactivity until a new and self-trained force was able to take up the intricate task of foundry production. Unquestionably, the human element is the keystone of the foundry arch and any failure now to build wisely and permanently will endanger the future welfare of this great industry.

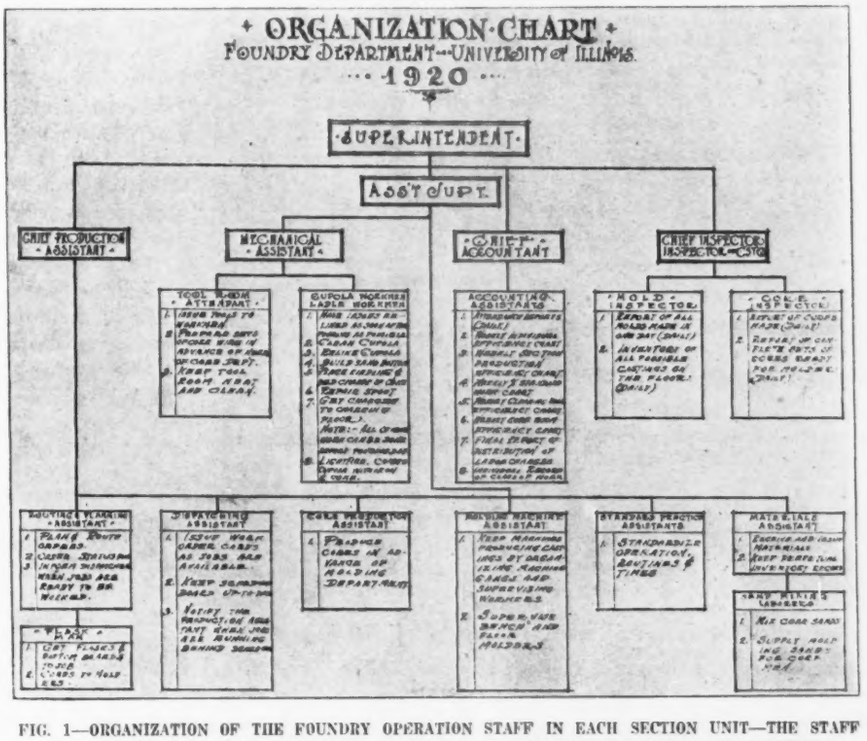


FIG. 1—ORGANIZATION OF THE FOUNDRY OPERATION STAFF IN EACH SECTION UNIT—THE STAFF HAS ENTIRE CHARGE OF OPERATION—STUDENTS ARE TRANSFERRED FROM ONE POSITION TO ANOTHER AT INTERVALS, SO THAT AT THE COMPLETION OF THE TERM EACH ONE HAS PERFORMED THE ESSENTIAL TASKS

The foundry organization as a whole, is composed of four groups, as follows:

Owners, and financially responsible operators.
Executives of the higher class.
Foremen and subforemen.
Workers of all classes in shop and office.

The first named group is small, comprising less than one-half of 1 per cent of all persons engaged in the industry. Financial or other considerations may overtop technical requirements in making selections for this group, so it is entirely possible to have men in this most important class who do not understand the technique of the foundry business. This type, lacking the basic knowledge of the work which comes from personal contact with it, normally may be expected to be more interested in the financial aspects of operation than in the human phases of it. This, of course, is the position of practically all nonresident stockholders. The examples of successful industrial ownership by men who have "grown up with the business" are so conspicuous that a broader extension of this type of ownership would go far toward bridging the artificial chasm that has in places grown up between employe and employer. The second group, or executives of the higher class such as managers and superintendents, is relatively small in numbers, but is of an importance equalled only by the first group. It consists of less than 1 per cent of the total number of employes engaged in the industry. Upon the men in this and the preceding group, numbering in the aggregate less than 2 per cent of the foundry organization, rests the entire responsibility for operation, for development and progress, and for conditions that affect the welfare of a multitude of people. In many instances these executives of high rank are in reality "the company" as they formulate policies and execute them. In every case the influence and power of this group is large, as it necessarily must be from the nature of industrial

From a paper presented at the Columbus meeting of the American Foundrymen's association. The authors, Bruce W. Benedict and Robert E. Kennedy, are in charge of the shop training courses at the University of Illinois, Urbana, Ill.

organization. Without doubt one of the greatest foundry problems today is training men for the higher executive positions. Although volumes have been written on this subject, and there are living examples of leadership of the highest type to pattern after, we possess no formula for this great task. "Leaders are born and not made" is a common saying that contains much truth. It is true insofar as character is concerned, since this fundamental element of leadership is the manifestation of the spiritual quality of man which is quite beyond the reach of human manipulation. But leaders are "made" when knowledge is added to character. The possession of character alone is not sufficient, nor is leadership attained by a mechanical process of acquiring knowledge. Regardless of the plan of training employed, the ultimate result will be naught if the basic traits of character are lacking. Leadership cannot be constructed on a foundation of sand.

It is not proposed to discuss the entire topic of training foundry executives, but that phase of it falling within the realm of the technical school. It goes without saying that a technical training is not an absolute requirement in the training of successful foundry executives. There are other routes of attaining the ends sought, but unquestionably the technical school is more direct and effective than any of those offered by the "school of hard knocks." A technical training develops the ability to think in logical and accurate terms; it stimulates the imagination and initiative; and enlarges the mental horizon until it includes a working knowledge of the fundamental laws of mathematics, science and engineering. It is preeminent as a medium for developing mental power. For a number of reasons, which space prevents mentioning here, it has not placed sufficient emphasis upon the development of those qualities which make for leadership. This fact is recognized by leading engineers and educators, and at present there is a pronounced tendency to remold curricula and teaching methods on lines that will make the technical schools ultimately more effective in this respect. A comparison of the courses of instruction as administered now and a few years ago by technical schools throughout the country shows that significant changes in educational methods are taking place. At the University of Illinois the reorganization of the courses in shop work to conform to modern industrial practice, is a typical example of this evolution in technical education. With the coming of the modern industrial era, with its revolutionary changes in methods of management and of production, industry has been demanding increasing numbers of men especially trained for and qualified to carry on the diversified tasks of the new order of things. Men are wanted who understand the principles of management, modern methods of production, the standardization of manufacturing processes, scientific methods of paying for work done, specialization of labor, economics of manufacturing, the development and use of labor saving machinery, and above all, the ability to organize and direct working forces.

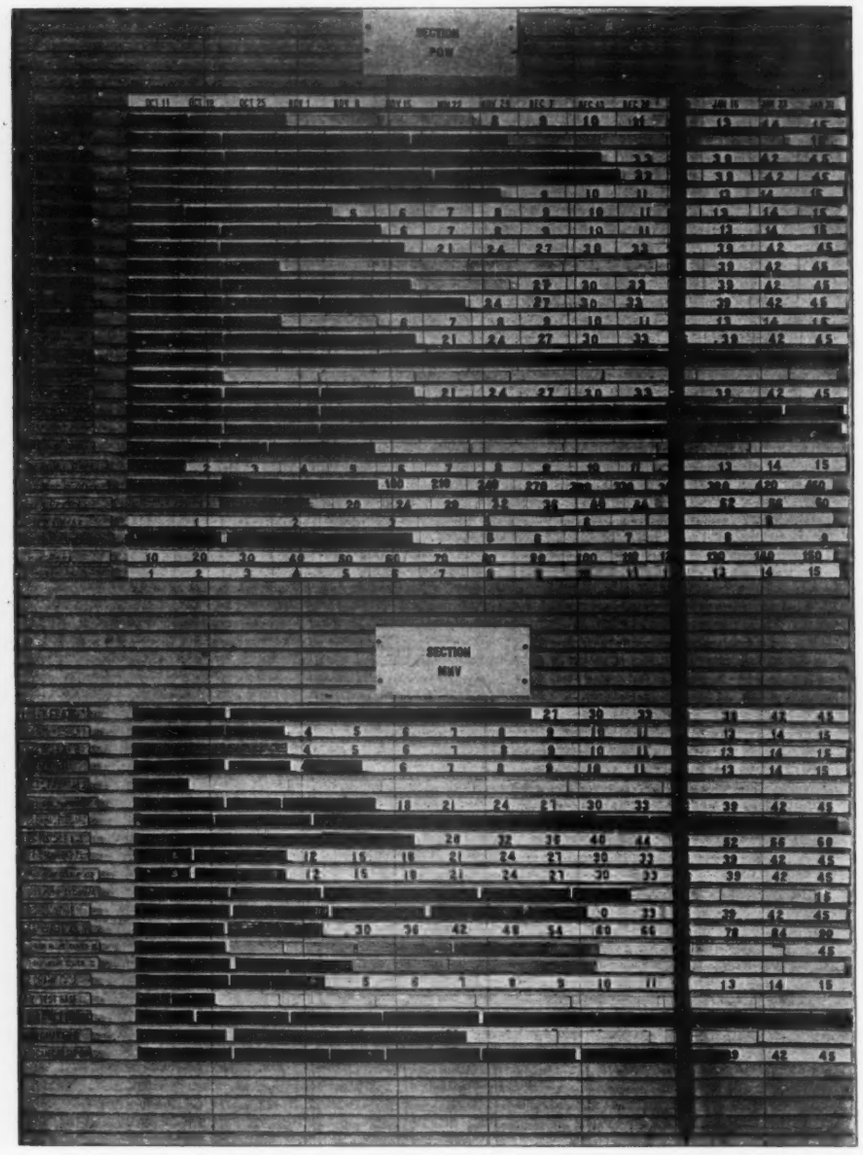


FIG. 2—A PORTION (FOR TWO SECTION UNITS) OF THE PRODUCTION CONTROL BOARD IN THE STAFF OFFICE, FROM WHICH THE PRODUCTION ASSISTANT DIRECTS THE WORK OF PRODUCTION IN THE SHOP—THE BOARD SHOWS THE STATUS OF ALL JOBS IN EACH SECTION UNIT

Sources of Executives

While the technical schools are the natural sources of supply for recruits to fill these specialized positions, it is obvious they have not been equipped with facilities especially designed for this particular task. The situation was met in part, at the University of Illinois, by organizing the shop laboratories as a manufacturing plant, for the purpose of creating an industrial laboratory that would provide training in real problems of operation and management. Insofar as available resources would permit the shop plant was arranged to manufacture a standard product (an 8-horsepower, 2-cylinder gas engine) by generally accepted shop production methods. Operations were standardized, working schedules provided, improved facilities installed, stock and tool rooms provided, and production control methods introduced in all of the four departments of the plant. The aim was to create a manufacturing laboratory in which the students as

workers and executives, would perform the various functions of production and of management incident to the manufacture of a commercial product. Since the year 1912, when the plan was adopted, the results have demonstrated that its ideals and working principles are fundamentally sound, and that it has great possibilities for further development. Close co-operation between industry and the technical school is essential to the fullest development of any plan of training, and it is the hope of further stimulating the great interest of this association in technical training that the administration of the plan in the foundry department is presented.

The ideals underlying the course in foundry instruction are:

> To promote knowledge of the principles of modern foundry management, by actual experience in directing the work of producing castings in a modern foundry by efficient methods.
>
> To develop a working knowledge of modern foundry practice by performing the work of producing castings with modern methods and equipment.

The operation of the plan is simple. At the beginning of the school term an order is issued by the superintendent for a given number of gas engine parts. As all work operations have been standardizezd, this work order represents a total working time in hours usually well within the total student shop hours. It is possible for the order to be completed before the end of the term, if the student managers plan their work as they should, and the student workmen attain the required efficiency of production. A definite standard of achievement is thus set up, which calls for the individual and collective effort of the entire class. The commercial foundry with all its problems of management and of technical performance, is transferred to the university laboratory. The training consists of the experience gained with real foundry operation.

After a short ppreliminary period of work at machine molding, coremaking and at the cupola, each of the four student sections (from 25 to 50 men) is organized as a complete foundry operating unit. Units are divided into two groups; (a) staff assitants, and (b) shop workers. The organization is shown by the diagram in Fig. 1. The staff plans and executes a production schedule to secure the completion of the required number of parts on the specified delivery dates. It issues work orders directly to the working group, and exercises the functions of foundry manager, foremen, inspectods and clerks. The working group do all the work of molding, coremaking, cupola charging pouring, cleaning, etc. General supervision is exercised by the foundry instructors who act as superintendents and assistant superintendent, but their part is instructional only. They assume no reponsibility for operation.

Students are transferred from one position to another at intervals, so that in the course of the term they perform all of the important tasks. The time is about equally divided between the staff and shop positions. Of the actual time spent at work on the floor, 60 per cent is devoted to coremaking and molding, while the remainder is occupied at the cupola, cleaning castings, and at general labor work. At the beginning of the term the assignments of each man are with accompanying dates, so the shifts from one position to another is accomplished automatically and with no confusion.

As each work operation is standardized, it is possible to predict the amount of work which each unit should produce from week to week. Immediately after the number of available student hours is established, a production output schedule is made by the staff and the number of castings to be completed from week to week is entered upon the records and the production control board is posted accordingly. A portion of this board showing the status of production for two section units at the close of the week of Dec. 20 is illustrated in Fig. 2. The board shows graphically the relation of actual output to expected output, and the status of work in the process of completion. Foundry operators in search for future executives can make selections with little change of error by observing the staff assistants directing the foundry activities from this board. The marked contrast in the ability of individual students to organize and direct the work of others is immediately apparent here. None of the conventional college examinations reveal this excedingly valuable information.

The staff is composed of the following members, called assistants: Production, mechanical, planning and routing, dispatching, standard practice, materials, accounting and inspection. The chief production assistant has entire charge of production. It is his duty to secure the required output by co-ordinating the activities of the various departments in his section. He is in effect the boss of the shop. He is directly assisted by the routing, dispatching, core-production and materials assistants, each one of whom performs special duties as indicated on the diagram in Fig. 3. Tools, machines and facilities used in the production of work are looked after by the mechanical assistant. Inspections of and reports concerning molds and cores made in each section unit are the work of the inspection assistants. Reports of shop performance, and of attendance, and preparation of production charts are made

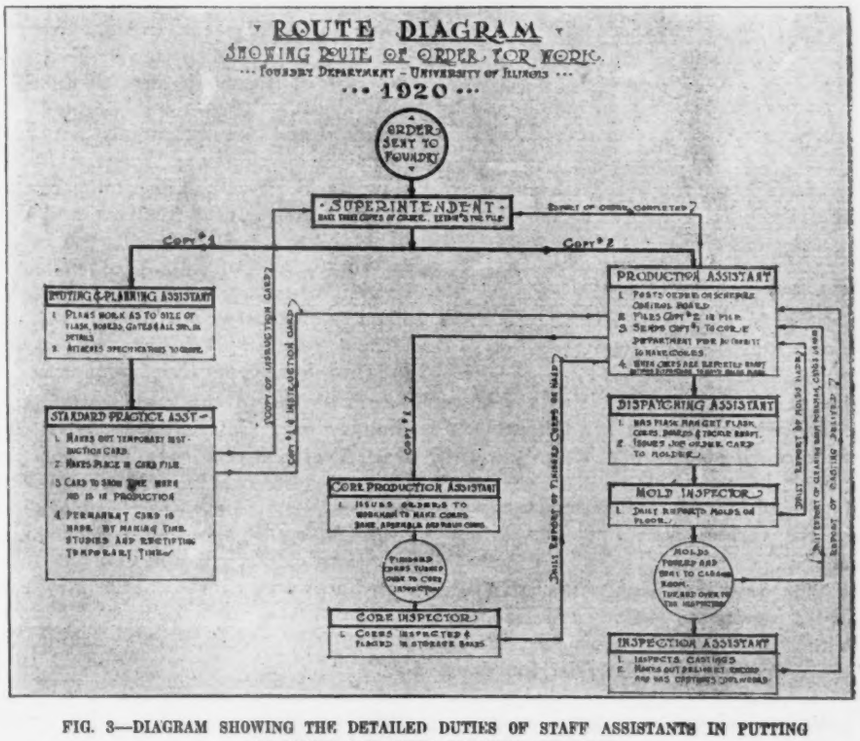


FIG. 3—DIAGRAM SHOWING THE DETAILED DUTIES OF STAFF ASSISTANTS IN PUTTING AN ORDER FOR WORK THROUGH THE SHOP

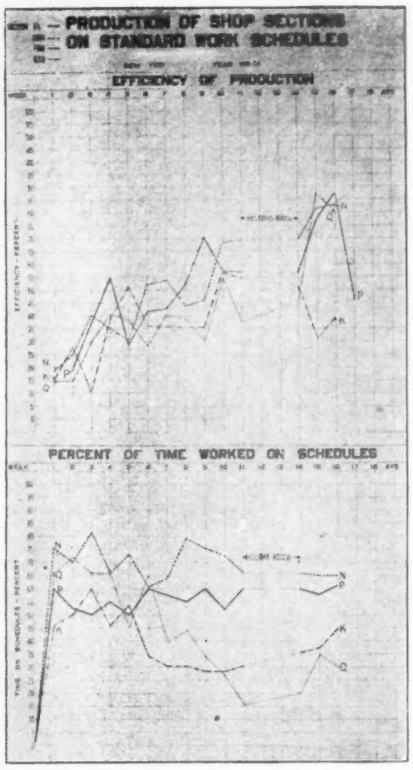


FIG. 4—PRODUCTION AND EFFICIENCY CHARTS MADE UP WEEKLY BY THE ACCOUNTING ASSISTANTS—THESE ARE DISPLAYED IN PROMINENT POSITIONS IN THE SHOP

by the accounting assistants Fig. 4. Standard instructions for the performance of all staff duties have been prepared in some detail so the more intelligent students take up the work of the various staff functions without difficulty.

The problems which the staff are called upon to solve are identical with those which are ever before the operators of commercial foundries. There are not only the usual routine problems of operation to struggle with, but also questions too settle regarding molding practice, use of pattern plates, mixing of iron and brass for castings, the employment of molding machines, etc. These problems are not solved by the instructors with the students as spectators. Responsibility for operation is squarely up to the staff, and it is their task to work out solutions by the aid of the standard instructions and with the friendly council of their instructors. The average staff has a sprinkling of born leaders in it, who thrive under the load imposed by this responsibility, and who are fully competent to solve their problems with the aids at hand.

In common with other college shops, the foundry is not eqquipped with the most efficient facilities in all instances, for the universal reason—lack of funds. Modern equipment is added from time to time, making it possible to demonstrate its productive capacity, and also to compare the relative economy of various methods of performing the same operations as noted in Fig. 5. Every opportunity is taken to stage these demonstrations in order to stimulate the imagination of the student workers and increase their interest in the development of improved methods and devises. Investigations are made in great detail with the aid of the stop watch and the results recorded by various observers on special forms. From the tabulated results, standard work schedules are prepared by standard practice assistants, and these are made up later in permanent form for shop use. This feature of the training is of considerable value in drilling the eye to observe accurately, and also to develop the practice of thorough investigation of the facts. The time devoted to molding and coremaking is not suffient to develop any great skill at these tasks. As the aim of the course is the training of executives and not of molders, the development of skill is considered of minor importance, but students expecting to enter the foundry industry are urged to acquire practical molding experience in a modern commercial foundry.

In addition to the regular staff and shop work, lectures are given on theoretical subjects such as properties of cast iron, cupola operation, molding practice, planning and scheduling of work, analysis of work operations, time study, etc. From time to time noted foundrymen (whenever they can be induced to come) and molding machine manufacturers give lectures on design of foundries, the production of castings, and molding machine operation. Lectures from prominent men in the foundry world are considered of great importance in this training, not only from their informational value, but also as demonstrations in personality.

Another feature of the course which has proved its worth is the systematic study of foundry trade literature, including magaziznes and catalogs. By a special arrangement with the publishers of *The Foundry*, students subscribe to this magazzine for a part year. Reading assignments from its advertising and editorial pages are issued at intervals, and students report on this matter in note books. This brings the student in contract with the latest developments in methods and equipment. Foundry problems involving designs of foundries for the production of certain lines of castings, layout of core rooms, selection of equipment for specific kinds of work, etc., are part of the required work. Exhibits of foundry interiors and of equipment, from magazines and catalogs are displayed to assist in the solution of these problems. The question of more efficient equipment for producing gas engine parts in the university foundry is a frequent matter of investigation. Reports are submitted recommending certain equipment selected from the available advertising matter, with arguments and figures to support the proposals made. It is obvious from these reports that

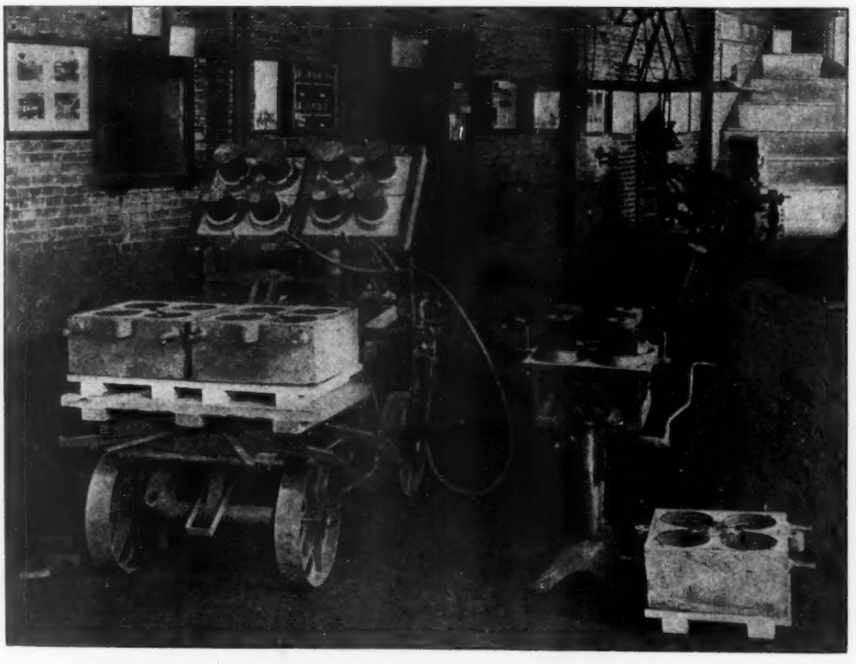


FIG. 5—PATTERNS ARE MOUNTED FOR DIFFERENT TYPES OF MACHINES, AND THE TIME AND COST OF MAKING MOLDS IS STUDIED IN DETAIL BY THE AID OF THE STOP WATCH—FROM THESE STUDIES, REPORTS ARE MADE UP WITH RECOMMENDATIONS OF PREFERRED PRACTICE

the better class of students (the future executives) gain clear conceptions of the principals of management and production, and are able to apply this knowledge in the solution of practical problems.

As the plan of instruction is identical in principle throughout the other departments of the shop laboratories, the student acquires during the entire shop course a rather definite understanding of the fundamental principles underlying the production of goods. He learns by personal experience the necessity of co-ordination between departments and how failures in planning and in organization shatter production and decrease efficiency. When in positions of responsibility he observes the results of careless and indifferent work from an angle that did not appear to him when at the bench or cupola. His experiences, although in minature, are the same as he would acquire under similar circumstances in the midst of industrial life

Roughly about 5 per cent of all students taking the shop courses display conspicuous talent of leadership and at the same time possess the essential elements of character. The percentage varies in classes. Some section groups contain men of outstanding executive ability, while others have none of this type. Engineering students are a selected group, but at that, the percentage of them destined to fill high places in the management of engineering or industrial affairs is relatively small. This group, small as it is, is worthy of the highest educational advantages which the wealthiest nation on the globe can bestow upon it. No other group of young men exceeds this one in importance, not alone to industry, but to society which industry serves. As the leaders of tomorrow they must be prepared for the weighty responsibilities awaiting them. This task is a joint one for the technical school and industry to carry on together by sympathetic and co-operation.

Steel Bars Melt First From the Inside

That steel melts from the inside has been observed by G. P. Blackiston who has furnished the two accompanying illustrations. In melting of steel in a crucible one of the pots broke during the melting process and was immediately removed from the furnace and set to one side. After the pot had cooled it was noticed that chunks of metal were present which possessed approximately the shape of the metal as originally charged into the crucible, which was made of numerous pieces of octagonal bar steel, such as is used for lathe and planer tools. When the pieces taken from the crucible were tapped with a hammer a hollow sound was noted, and upon further investigation the pieces were found to be hollow. It may be noted from the illustrations that the pieces have retained approximately their original contour, except that in the process of melting the molten metal in the inside found weak spots in the outer shell and passed through the openings which it made at these points.

Mr. Blackiston explains the phenomenon by stating that pure iron has a higher melting point than steel and the more carbon there is in the steel, the lower its melting temperature. The outer layer of these bars of tool steel received the heat first, but this heat was, no doubt, immediately transferred to the inner portion. As the heat continued to be added, it is believed, the carbon was burned out of the outer layer forming it into a low-carbon steel approximating iron itself. The inner layer still retained its car-

METAL MELTED IN THE CENTER AND RAN OUT LEAVING THE SHELL

Effect of Copper on Cast Iron

Question.—We are making cast-iron water jackets for copper smelting furnaces and desire to try an addition of 2 per cent copper. Please let us know the best method of making the 2 per cent copper addition and what benefits, if any, are likely to be derived from such an addition.

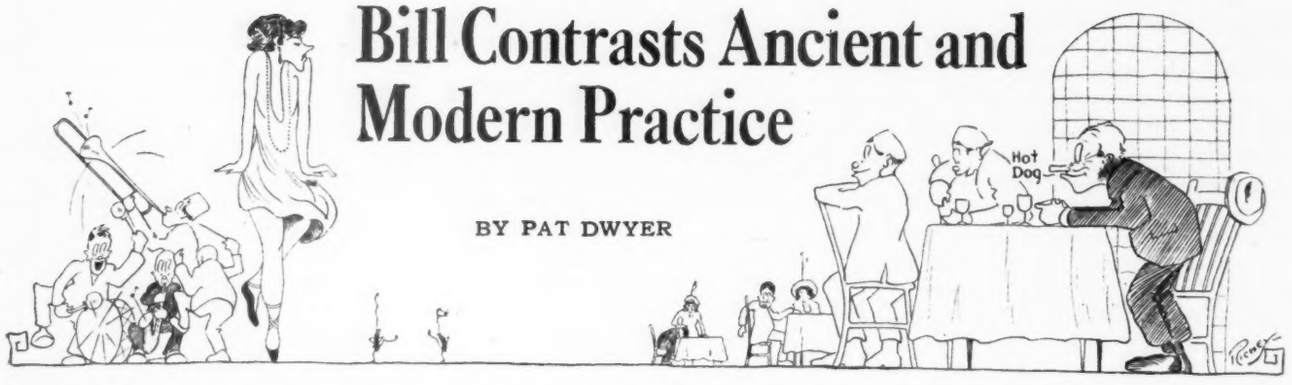
Answer.—Copper could be added directly to the molten cast iron, or in the form of ferrocopper alloy containing equal parts of copper and iron. This ferroalloy could be made by adding molten copper to molten steel or iron and stirring well. The effect of the addition of copper to cast iron is not well known. There is more or less dispute regarding the effect of copper on steel. It is claimed by many that over 1 per cent of copper makes steel red short and difficult to weld, whereas others claim that these effects are not noticeable even when as much as 5 per cent of copper is present. Copper above 2 per cent in steel tends to segregate, but this tendency can be reduced by the simultaneous addition of nickel. The effect of copper on iron would probably be analogous to the effect of a similar percentage of copper on steel.

New Materials Advanced for Furnace Linings

Discussing refractories in a paper before the Electric Furnace association, at the meeting in Columbus, O., Oct. 6, C. W. Berry, La Clede Christy Clay Products Co., St. Louis, said regarding basic furnace linings: Zirconia is one of the latest materials to be offered as a refractory material. It has a high fusion point, and shows resistance to slags of certain types and gives promise of being a valuable refractory. Another type of basic refractory is a spinel of magnesia and alumina. These brick were tested in an electric furnace bottom below charging door in comparison with magnesite and bauxite brick, and lasted more than twice as long. Sillimanite is a material that has been produced from fireclay by removing part of the silica and promises to make a highly refractory product. Sillimanite shows considerable resistance to slag penetration and holds up well.

Bill Contrasts Ancient and Modern Practice

BY PAT DWYER

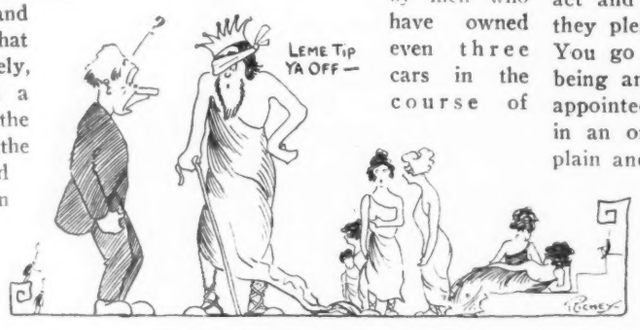


A MUTUAL friend of Bill's and mine blew into town the other day. He had some business to attend to during the day and expected to leave again on the midnight train, and consequently it looked as if we were not going to have much opportunity to enjoy each other's society. I got in touch with Bill, whose family was out of town and the three of us arranged to have a quiet little dinner at our friend's hotel, go to a show and afterward spend the evening in discussing once again the stirring events that characterized the days when we were twenty-one.

With the exception that his waistline had increased to an alarming extent and his hair had decreased in inverse ratio, our friend was the same old boy he had been in the days when we pounded sand together in the day time and borrowed each other's clean shirts at night. In those days we were in the same class as Solomon and his Lilies, we did not care what we ate or drank, no indeed, and in the matter of clothes I bet that either individually or collectively, we could have given Solomon a run for his money. 'Tis true the ancient monarch had a trifle the edge on us in his reported matrimonial exploits, but then allowance must be made for the changed social conditions since his day. I always had my doubts about the authenticity of that matrimonial chapter in the Book of Solomon and am inclined to think it has been translated too literally and without due regard to keeping the narrative within the bounds of probability. Some of our esteemed fellow citizens from the state of Utah tried to emulate his example during the past century but the records fail to show that any of these heroes ever paid milliner's bills and dressmaker's bills for more than a dozen ladies at one time. To save their faces they put up a half hearted kick when polygamy was abolished; but it is significant that there followed no general exodus to set up a new colony afterward.

I am perfectly willing to admit that Solomon *may* have had 700 or 1000 wives—after you pass the first hundred 300 or 400 either way does not make much difference—but I do not believe that he lived with them all at one time. Solomon enjoys the reputation of being the wisest man who ever lived and if he survived 1000 wedding ceremonies, 1000 wedding breakfasts and developed a system for meeting the bills for 1000 Easter hats every year, he certainly deserves the title.

My own impression is that he secured his wives much after the fashion in which the modern man acquires his automobile. That is he got a new one on the first of the season. After a month in some cases, and probably a much shorter period in others, he traded her in for a new model and so on several times a year until he had reached the 1000 mark. When you reflect on the omniscient air affected by men who have owned even three cars in the course of their lives it is readily apparent how Solomon's reputation for wisdom was established.



VANITY OF VANITIES AND ALL IS VANITY

However, all this has nothing to do with what I started to write about. It just goes to show how easily a man's mind is diverted and how willing he is to go whither his fancy leads him. Solomon was free to follow his inclinations while the rest of us—Oh, well, let it go at that. I am afraid if the lady who graciously consented several years ago to share my name and any other worldly goods I possessed or might acquire in the future, ever happens on these lines I will need a fair share of Solomon's wisdom to preserve the *status quo*. In other words to furnish a satisfactory explanation for a peculiar American colloquialism to which she sometimes descends—"How Come?"

We met at the hotel, had dinner in the cabaret grill and then at Bill's suggestion we went to see a minstrel show.

"This grand opera stuff may suit some people," said Bill on the way to the theater, "but not for me. I have no fault to find with it and have tolerated it on several occasions; but I derived little satisfaction or pleasure from the performances. Watching and listening to supposedly intellectual people dressed in ridiculous garments and whose sole ambition seems to be to see how long they can hold their last or highest note never appealed to me. Besides, I never could understand a word they say. Now a minstrel show is different. The men taking part dress, act and look ridiculous and therefore they please one's sense of consistency. You go there with the expectation of being amused and you never are disappointed. They sing ordinary songs in an ordinary way. The words are plain and you have no difficulty in following the meaning." "Why the panegyric?" I said. "To hear you talk one would imagine that you were rehearsing for a bally-hoo job at a street fair next summer. You seem to forget that neither Jim nor I ever needed any coaxing to attend one of those shows; that we contributed our share of the applause and probably graced as many galleries with our presence and ate as many peanuts while watching and listening to the cork faced boys as any persons of our weight and age in this land of the free and home of the brave. It is a long way back to '98 when we first saw Primrose and Dockstader in the old Lyceum in Detroit; but we have seen many a minstrel show since that time and believe me we are going to see them as long as we can scare

up the price for a gallery ticket."

After the show we walked down the street and the conversation turned on the activities of a certain dramatic club with which we had been more or less prominently identified in the days of our youth. Among the offerings which we presented to the inhabitants of the old home town during the period of the club's existence, we had on one occasion put on a minstrel show.

"That was the year I left home," said Bill. "I had finished serving my time in the foundry and had worked for a year and a half as a journeyman molder. I was then a trifle over 21 years old and had a great deal more confidence in myself, mental, moral and physical that I have ever had since. That show tonight reminded me of how self satisfied we were and how we patted each other on the back after our amateur minstrel show was over. I had not been long away from home when I saw a *real* minstrel show and about the same time I went to work in a *real* foundry and from that day to this I have never patted myself on the back with a smug feeling of satisfaction that I was perfect and had nothing more to learn.

"You remember the bed plate castings we used to make for the hoisting engines in the coal mines? Those castings which were about 10 feet long, of rectangular cross section, 12 x 18 inches, closed on three sides, open on the fourth side and cast open side up? When I look back at the method adopted and in use as long as I can remember for molding this job I feel ashamed to think that the easy and obvious way which I learned later in another shop did not occur to me.

"I do not refer particularly to the manner in which the mold was rammed, finished, blacked and poured. What I have in mind is the method adopted for setting the long, deep, dry sand cores which were employed for forming the inside of the casting. Of course they might have been set on chaplets in the drag; but the danger of such practice lay in the fact that if the cope did not bear down heavily all over the top face of the cores, they were likely to shift under the pressure of the molten iron and to produce a casting of unequal thickness in some of the sections. In addition to being an objectionable feature from an engineering viewpoint, such a shift would interfere with the natural contraction of the casting and likely cause it to warp out of shape either sideways or up and down.

"It is a delicate problem to provide for the natural distortion of a casting

THERE ARE NO BOYS LIKE THE GOOD OLD BOYS

of this description while cooling, on account of the thickness of the plate on the bottom. If the cores are not set absolutely true, it is impossible to do so. If the core was in one piece, extending from one end of the mold to the other the danger would not be so great; but in the job under consideration, the core was in several sections to provide for transverse ribs in the casting.

"The logical course to pursue under these or similar conditions is to suspend the cores from the cope. This does away with the chaplets, and also insures that the cores will not shift. Another point in favor of this method lies in the fact that it precludes any possibility of the iron creeping in over the tops of the cores and getting into the vents.

"The contrast between the method by which these cores were attached to the cope in the old shop and the manner in which the job was handled in shops which later I favored with my company is what I wish to direct your attention to.

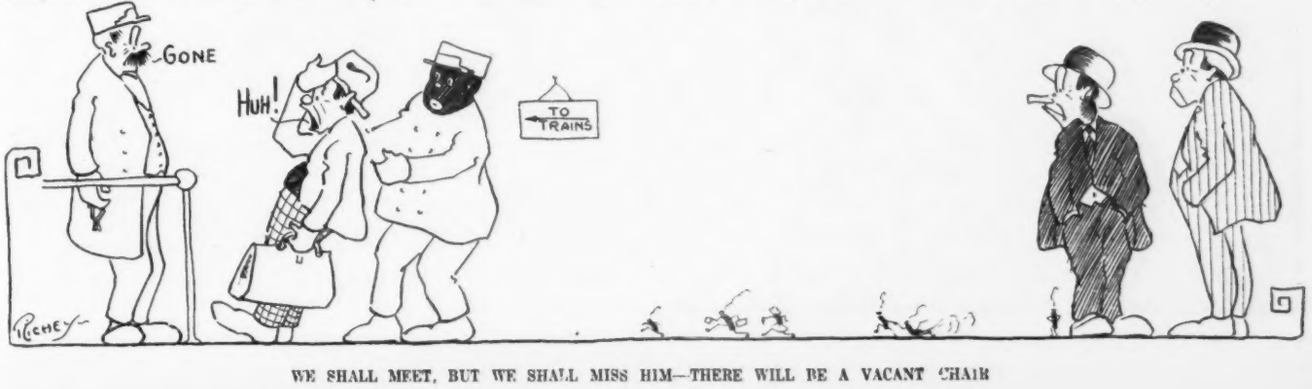
"In the first instance, the pattern was built in the ordinary box style and provided with core prints 1½ inches high on the cope side. These core prints were objectionable inasmuch as the bars in the cope had to be cut out to accommodate them. If a flat iron cope was employed it meant that the pattern had to be kept about an inch below the parting line and this in turn left a projecting body of sand all along both edges which usually was crushed at two points by the blocks on which the cope was rolled over. However, that was not the principal disadvantage of the method. After the cope was rolled over it was lifted and set on four stands. The cores were then set and secured in place by bolts which passed through the cope which were tightened by nuts and washers on the under side. The cores were set by guess and it was purely a case of guess and judgment whether they would hang plumb when the cope was turned over. These cores stood from 12 to 18 inches above the face of the cope and it was necessary to attach braces to the side of the cope to prevent them from sagging while the cope was going over.

"Just contrast all that time, trouble and guess work with the method which I found in vogue elsewhere.

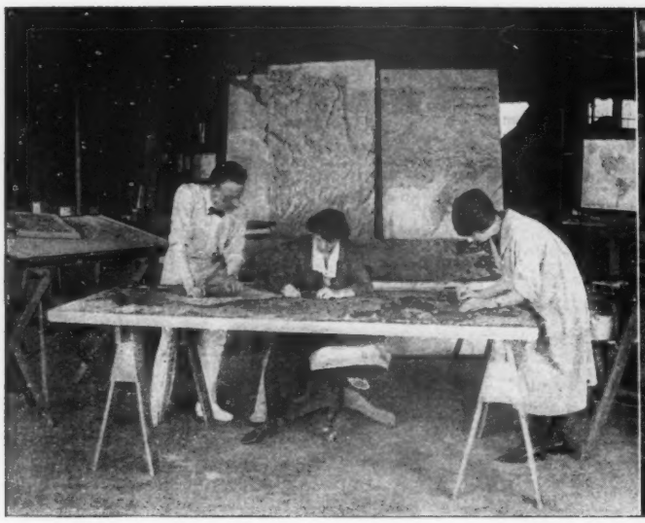
"The pattern was made in the same style as the other with the exception that there were no core prints. Instead, the outline of the cores was painted on the cope side. A plain flat cope was employed and a number of blocks rammed in the bars which came over the outline of the cores. The cope was lifted off but was not turned over; what little finishing was necessary was done overhead before the cope was lowered off and the wooden blocks knocked out.

"Pieces of plank, corresponding to the thickness of metal in the bottom of the casting were laid on the bottom face of the mold and the cores lowered into place. Thickness pieces of wood were held against the side

(*Continued on page* 928)



WE SHALL MEET, BUT WE SHALL MISS HIM—THERE WILL BE A VACANT CHAIR



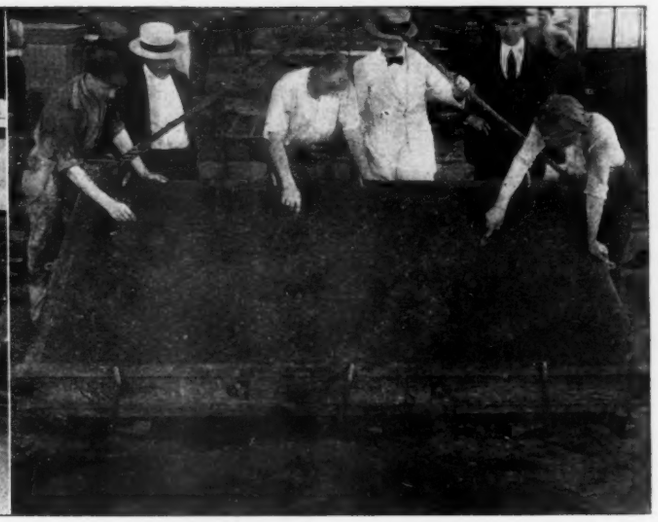


FIG. 1—PREPARING THE WAX PATTERNS, 20 IN NUMBER, FROM WHICH THE SAND MOLDS WERE MADE FIG. 2—THE DRAG HALF OF ONE OF THE MOLDS TIPPED UP ON ONE SIDE TO SHOW THE APPEARANCE OF THE FACE OF THE MOLD

Cast-Aluminum Relief World Map

A PROMINENT feature of the exhibit at the Marine Show held in New York last April was a large relief map of the world showing the physical conditions and the ocean trade routes of our merchant marine. The map composed of bees wax built up on wooden panels was made especially for the New York show under the direction of Commissioner T. A. Scott and Capt. Paul Foley, director of operations, in order that the public might visualize the constructive operations of the United States shipping board. It was painted by Faith Marsh and W. Lawson Guppy to show the verdure and climatic conditions on land, from the frigid zones to the equator and also the temperature, velocity and direction of the ocean currents.

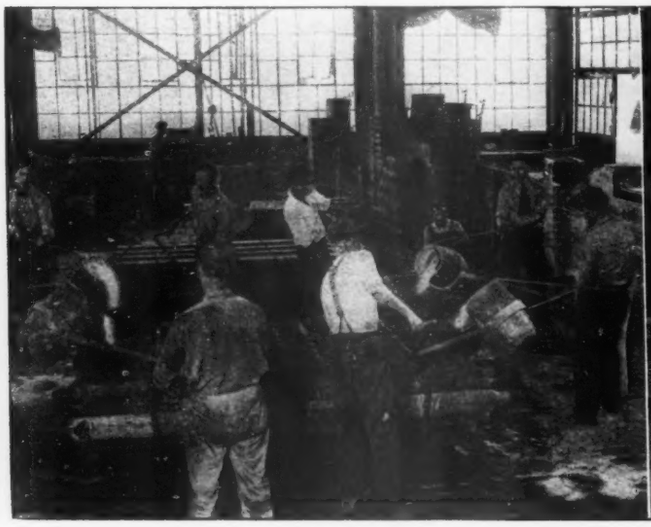
The model was of such a highly instructive character and attracted so much attention that the board decided to preserve it in permanent form and authorized its duplication in metal. The castings were made from an aluminum alloy at the foundry in the Washington navy yard.

Special Sand for the Mold

The wooden and wax panels first were taken to the pattern shop where the necessary additions including allowance for shrinkage and for a machined fit at the joints, were provided. They were then taken to the foundry and molded in a special grade of fine sand imported from the Catskill mountain district for that purpose.

The assembled map 42 x 15 feet and weighing approximately two tons is made up of 26 panels accurately fitted together and enclosed in an angle-iron frame which forms an easel for this huge picture. After it was finished it was shipped to Chicago where it was reassembled and painted by W. Lawson Guppy, the artist who conceived and executed the wax model. It was exhibited at the National Marine show held in the Coliseum, Chicago, Oct. 18-23, as part of the United States shipping exhibit and had for a setting a sculptured frame and court of a maritime character designed by the same artist and executed in marble and bronze by Beil & Harmant, Chicago.

Admiral Benson, chairman of the Shipping board, appeared in Chicago personally and participated in the formal opening ceremonies with a speech. Capt. Paul Foley, head of the operating division of the board is chairman of the committee on shipping board exhibits.



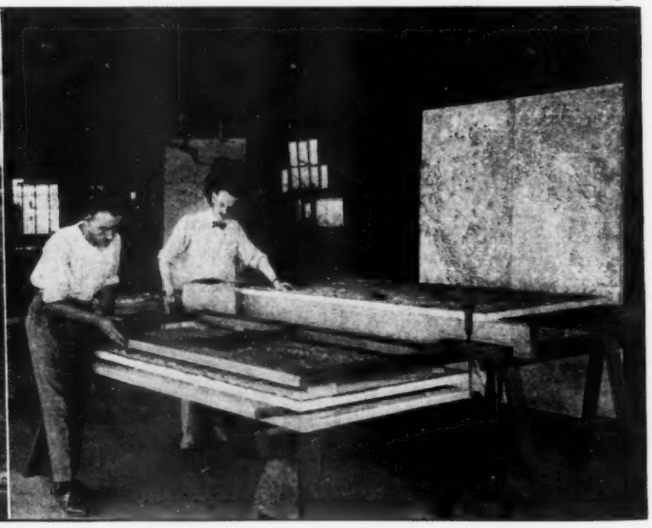


FIG. 3—THE MOLDS WERE GATED AT THE CORNERS OF THE FLASK AND POURED FOUR UP FIG. 4—AFTER THE CASTINGS WERE CLEANED THE JOINTS WERE LAID OFF ACCURATELY BY GAGE AND TEMPLET

STANDARD SPECIFICATIONS FOR GRAY-IRON CASTINGS*

1. These specifications cover three classes of gray-iron castings, as follows:
(a) LIGHT CASTINGS, those having any section less than ½ inch in thickness;
(b) HEAVY CASTINGS, those in which no section is less than 2 inches in thickness;
(c) MEDIUM CASTINGS, those not included in either of the above two classes.

2. The tension test will be made only when specified by the purchaser and at his expense. **

1. MANUFACTURE

3. The castings shall be made by the cupola process, unless furnace iron is specified.

II. CHEMICAL PROPERTIES AND TESTS

4. (a) Drillings taken from the fractured end of the transverse test bars shall conform to the following requirements as to sulphur:

Light castings	not over 0.10 per cent
Medium castings	not over 0.10 per cent
Heavy castings	not over 0.12 per cent

(b) One sulphur determination shall be made for each mold of test bars cast, in accordance with the standard methods for sampling and analysis of pig and cast iron (serial designation: A64) of the American Society for Testing Materials. In case of dispute, the standards of the U. S. bureau of standards shall be used for comparison.

III. PHYSICAL PROPERTIES AND TESTS

5. (a) The transverse test specimens (arbitration test bars) specified in section 7 (a), when placed horizontally upon supports 12 inches apart and tested under a centrally applied load, shall conform to the following minimum requirements, interpreted in accordance with section 9:

	Class of Casting		
	Light	Medium	Heavy
Load at center, lb.	2500	2900	3300
Deflection at center, in.	0.10	0.10	0.10

(b) The rate of application of the load shall be such that a central deflection of 0.10 inch is produced in from 20-40 seconds.

*Adopted as standard by the American Society for Testing Materials, 1918.

**It is recommended by committee A-3 on cast iron that the tension test shall not be made, for the reason that cast iron is almost devoid of elasticity, and hence any deviation from an absolutely straight pull in commercial testing machines yields defective results.

(*Continued on Data Sheet No.* 358)

STANDARD SPECIFICATIONS FOR GRAY-IRON CASTINGS

(*Continued from Data Sheet No.* 357)

6. When tension tests are specified, the tension test specimen shall conform to the following minimum requirements as to tensile strength:

Light castings	18,000 lb. per sq. in.
Medium castings	21,000 lb. per sq. in.
Heavy castings	24,000 lb. per sq. in.

7. (a) ARBITRATION TEST BAR—The form and dimensions of the mold for the arbitration test bar shall be in accordance with Fig. 1. The bottom of the bar shall be 1/16 inch smaller in diameter than the top, to allow for draft and for the strain of pouring. The pattern shall not be rapped before withdrawing. The flask shall be rammed up with green molding sand, a little damper than usual, well mixed and put through a No. 8

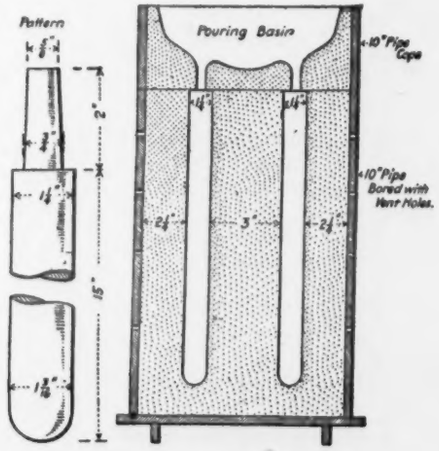


Fig. 1—Mold for Arbitration Test Bar

sieve, with a mixture of 1 to 12 bituminous facing. The mold shall be rammed evenly and fairly hard, thoroughly dried, and not cast until it is cold. The test bar shall not be removed from the mold until cold enough to be handled. It shall not be rumbled or otherwise treated, being simply brushed off before testing.

(b) TENSION TEST SPECIMEN—When tension tests are specified, the tension test specimen shall be turned from any of the broken pieces of the transverse test specimens, and shall conform to the dimensions shown in Fig. 2.

(*Concluded on Data Sheet No.* 359)

THE FOUNDRY DATA SHEET, NOVEMBER 15, 1920
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 6 x 7 inches, and may be readily bound in note book form.

Refractories For Electric Furnaces

Survey Is Made of the Different Materials and Tables Are Given of Their Physical Characteristics—Fusion Points Lowered by Pressure—Silica and Magnesia Tend to Spall

BY R. M. HOWE

NINE raw materials are most commonly employed in, or are being seriously considered for use in, the manufacture of electric furnace linings. They are fireclay, silica (or ganister), magnesite, dolomite, chromite, bauxite (and disapor), zirconite, carborundum, and alundum. The last two are mentioned by their trade names as considerable data are given as applying to these products. Strictly speaking they are not raw materials but can be classed as such most advantageously, and used to represent this general type of material.

The ranges of analyses shown in Table I, are believed to be typical of the materials used for refractory purposes. The refractory bricks or shapes made from these materials have similar anlyses. In many cases the difference in composition between the raw material and the finished product is simply due to the removal of carbon dioxide, water, or organic matter, but in a few cases it is the result of the addition of a binder, as for example the lime in silica brick.

The fusion points of a number of refractory brick were published by Kanolt in 1912 and as they agree closely with those secured by the writer Kanolt's results are given here. That of zirconia brick has been determined by several investigators but the results of Arnold and Ruff show the best agreement, being 2600 degrees Cent. and 2563 ±10 degrees Cent., respectively. Fused bauxite, or alundum, fuses at 2050 degree Cent. Silicon carbide, or carborundum, does not fuse but decomposes at about 2240± 5 degrees Cent. The following list gives the fusible point of refractory brick:

Fireclay—1615 to 1715 degrees Cent.
Silica—1700 to 1705 degrees Cent.
Magnesia—2165 degrees Cent.
Chrome—2050 degrees Cent.
Bauxite—1565 to 1785 degrees Cent.
Zirconia—2563 to 2600 degrees Cent.
Carborundum—Decomposes at 2240 degrees Cent.
Alundum—2050 degrees Cent.

When the fusion point of refractory material is determined the results actually show the temperature at which a small piece of the material softens under its own weight. Far different results obtain when the influence of pressure, as well as that of high temperatures, is taken into consideration. Fireclay brick begin to compress slowly at about 1350 degrees Cent. when a pressure of 50 pounds per square inch is applied. Zirconia brick *squatted* at 1420 degrees Cent. and 1600 degrees Cent. under pressures of 75 and 25 pounds per square inch respectively. Magnesia, chrome, and silica brick usually show slight signs of softening under pressure and then suddenly shear. Load tests on bauxite brick showed compressions of from 1.96 to 6.35 per cent under a pressure of 25 pounds per square inch at 1350 degrees Cent. after 1½ hours.

Carborundum brick do not fail at 1650 degrees Cent. under a pressure of 50 pounds per square inch. The following table of results secured by several investigators indicates what may be expected of different kinds of refractory brick, when heated under a pressure of 50 pounds per square inch.

Fireclay—Softens about 1550 degrees Cent.
Silica—Rigid at 1500 degrees Cent. but probably shears about 1600-1650 degrees Cent.
Magnesia—Shears at 1410-1555 degrees Cent.
Chrome—Shears at 1400-1450 degrees Cent.
Zirconia—Spalls about 1510 degrees Cent.
Bauxite—Softens about 1350 degrees Cent.
Carborundum—No signs of failure at 1650 degrees Cent., the furnace limit.

The following data, gathered from different sources, illustrate rather clearly how the weight of an installation depends upon the type of bricks used.

Material	Specific gravity
Fireclay	2.65-2.75
Silica	2.29-2.44
Magnesia	3.44-3.60
Chrome	3.90-4.00
Carborundum	3.12-3.20
Bauxite	3.15-3.25
Alundum	3.90-4.00
Zirconia	5.00

The higher values for zirconia, bauxite, chrome, magnesia, and fireclay brick generally indicate harder burning, while the specific gravity of silica brick decreases with the intensity of the burn.

It is natural that interest in the electrical resistivity of refractories should increase with the more general application of electric furnace, yet little information on the subject is available. Stansfield, MacLeod, and McMahon have compared the resistivity at high temperatures of silica, Austrian magnesia, and chrome brick made in America, and firebrick from Caledonia. Certain data regarding the resistivity of electric furnace products, is given in trade catalogs, but otherwise there is little information published. Table II shows the electrical resistivity at different temperatures, in ohms per cubic centimeter, of several refractories.

Aside from the data given by Hayne for silica and magnesia brick, and that given by Mellor for fireclay brick, little is known regarding specific heats of refractory bricks. Other investigators have simply reported determinations over a narrow and low temperature range and have apparently disregarded the fact that specific heat increases with the temperature. The following table gives the specific heats of several materials at 100 and at 1000 degrees Cent.

Material	At 100° C.	At 1000° C.
Firebrick	.199	.253
Silica	.219	.298
Magnesia	.231	.324
Alundum	.198	....
Carborundum	.186	.310 (985° C.)

The thermal conductivity of refractory brick has been determined several times, and in a number of instances remarkable checks have been secured. In nearly every investigation, however, there has been one marked deviation which has been due to the material used. When these apparent discrepancies are eliminated, the results show rather close agreement, as may be seen in the following table of selected data.

Thermal Conductivity of Refractory Brick at 1000°C. in colonies per centimeter cube per second per degree centigrade

Fireclay	Silica	Magnesia	Chrome	Carborundum
.0034	.0042	.....	.....	.....
.0042	.....	.0071	.0057	.0231
.0040	.0046	.0085	.....	.....
.....	.....	.0080	.....	.....
Ave.. 0039	.0044	.0079	.0057	.0231

Zirconia brick are said to have a very low thermal conductivity. That of silica brick has been observed to show a pronounced increase at 1050 to 1100 degrees Cent.

Refractory brick and shapes made from fireclay and electric furnace products are only slightly affected by sudden changes in temperature. Silica, magnesia, and chrome brick must be heated very slowly, especially at low temperatures, if spalling is to be avoided. When once heated, however, any of these bricks will withstand considerable variation in temperature if the change is not too sudden. The more important data regarding the thermal properties of the various refractories have been grouped in Table III. In many instances specific data is lacking so the writer has taken the liberty of supplying relative data or

Paper read before a meeting of the Electric Furnace association held in Milwaukee, Oct. 6. The author, R. M. Howe, is senior industrial fellow of the Refractories Manufacturers' association at Mellon Institute of Industrial Research University of Pittsburgh, Pittsburgh.

comparative notes to aid in the formulation of conclusions. The specific data represents the average results obtained.

There is little doubt but that the use of fireclay brick for metallurgical purposes is advisable wherever they give satisfaction. They are inexpensive, easy to install, and require less care in handling than any other refractory material. However, it is realized that there are serious limitations to the application of fireclay brick in the electric furnace industry because of the extremely high temperatures involved. Consequently, it is necessary to secure the most refractory firebrick available for use in the hotter zones and even then the furnace temperature should not exceed 1650 degrees Cent. for any length of time. Since this temperature is close to the fusion points of the more refractory fireclays, satisfactory service can only be secured by applying certain precautions which tend to increase the life of any refractory.

Insulation of any kind should be carefully avoided when fireclay brick are used at their limiting temperatures, for when the heat which is naturally carried away accumulates on the inner hotter surface failure invariably results. Care must be exercised in preventing the accumulation of plant dust on the furnace roof for it acts as an insulator and sometimes causes failure. It is also advisable to make the ratio between the heating surface and the radiating surface as small as possible in order to secure additional service from the lining. Undoubtedly the use of water-cooling plates would be advantageous as has been demonstrated in the hotter zones of a blast furnace. A refractory block should never be heated from more than one surface, especially when under pressure. The results of this condition are shown by the load tests. These rules are not restricted in their application to fireclay brick alone but apply to any kind of refractory material.

When fireclay brick do not give satisfactory service in roofs, silica brick are usually installed. They have fusion points which are practically the same as those of the more refractory fireclay brick but possess other characteristics which favor longer service. They must, however, be heated very slowly, especially at the lower temperatures, because of their tendency to spall. When this precaution is taken and a temperature of over 1000 degrees Cent. is maintained a silica brick roof should give extended service.

When the roof is heated rapidly strains develop, but are often unnoticed because the expansion of the brickwork holds the brick and pieces in place. Upon cooling, however, the brickwork contracts and reduces the pressure on the different parts of the roof thus allowing the loosened portions to fall into the hearth. It is believed that if the pressure could be maintained during a cooling period spalling would be less pronounced. Upon heating up again it would be necessary to gradually release the pressure to allow for the expansion of the brick, in order to prevent them from crushing themselves.

It has been the writer's experience that the smaller silica shapes spall less readily than the heavier blocks, due probably to the great expansion strains developed in the latter during the heating periods. This fact would favor the use of small standard sizes rather than the larger special shapes.

There are two characteristics possessed by silica brick which are associated with their satisfactory service in roofs. These brick have a relatively high thermal conductivity which helps cool the brickwork, and they are rigid under a pressure of 50 pounds per square inch at temperatures within 100 degrees Cent. of their fusion points. It is believed that these two facts, coupled with the high viscosity of silica, explain why brick of this type can be used at temperatures close to their actual melting points. Care should therefore be exercised in furnace design and construction to develop the thermal conductivity of the walls to the maximum. Bricks made from various sized angular fragments and burned so as to convert a large proportion of the quartizite to tridymite and cristobolite (indicated by specific gravity of 2.29-2.38) usually have the greater strength at high temperatures.

The use of fused silica brick has not been overlooked and it is doubtful if they would spall. However, their cost would hardly be justified as more refractory electric furnace products could be prepared at a slightly greater expense.

Magnesia brick are favored with a high fusion point, thermal conductivity, and resistance to the corrosive action of slag and metal. Because of this fact the brick and grains are used extensively in the hearths and bottoms of basic furnaces. They have less desirable characteristics of being subject to spalling and to the chemical action of certain substances. Extreme care must therefore be exercised in the selection, treatment, installation, and use of this material.

The magnesite after being burned should contain from 4.0 to 8.5 per cent of ferric oxide, as this impurity facilitates sintering. When this amount of iron oxide is present and the specific gravity is from 3.44 to 3.60 the product is sure to be well burned, resistant to slaking and will undergo little or no contraction after being installed. Either the grains or the brick made therefrom may be stored indefinitely if protected from water. However, these characteristics will be affected by the lime content which, as is generally conceded, should be low. Investigations reported elsewhere have led to the conclusion that magnesite with lower lime content showed less tendency to slake and higher refractoriness, as well as greater resistance to attack by firebrick and silica brick, and to the action of the corrosive mixture.

Dense hard-burned magnesia brick have a thermal conductivity higher than that of silica brick and permit only slight slag penetration. They should be laid dry in order to prevent any possible action with water and should never be exposed to the action of steam, which causes them to disintegrate. They are attacked by carbon at 1700 degrees Cent. according to the following reversible equation $MgO+C=Mg+CO$. As this action proceeds a gray or black deposit consisting of an intimate mixture of magnesia and carbon is deposited in the cooler zones. Both silicon and phosphorus also attack magnesite when they are present in the melt, that high in lime being most easily affected.

When the grains are used in the health they should be sintered into place in ½ to 1-inch layers over a foundation of magnesia brick, using a small amount of slag as a binder. This practice should result in the formation of the densest structure, one which would be

TABLE I

Composition of Refractory Raw Material

Material	Fireclay Per cent	Ganister Per cent	Magnesite Per cent	Dolomite Per cent	Chromite Per cent	Diaspor and Bauxite Per cent	Zirconite Per cent	Carborundum Per cent
Ignition loss ..	3–16	up to 5	48–52	42–48	.....	15–31	2.72	.....
Silica.....	40–70	96–99	up to 5	up to 4	3–10	4–10	7.74	.....
Alumina.....	45–15	up to 2	up to 1	up to 4	10–25	52–72	.66	up to 2
Iron oxide.....	up to 5	up to 2	up to 5	up to 4	14–19	2–6	3.10	up to 1
Lime.....	up to .7	up to .5	up to 3	27–34	trace	trace	.....	up to .3
Magnesia.....	up to .7	up to .5	40–47	16–20	11–17	trace	.....	.....
Alkalies.....	up to 2	up to .6	.....	.....	.....	trace	.....	.....
Zirconia.....	.....	.....	.....	.....	.....	.....	84.1	.....
Chrome oxide....	.....	.....	.....	.....	36–46	.....	.....	.....
Carbon.....	.....	.....	.....	.....	.....	.....	.....	27–30
Silicon.....	.....	.....	.....	.....	.....	.....	.....	65–70
Titania.....	up to 2	trace	.....	.....	.....	1–5	1.21	.....

less easily scoured or loosened in patches.

Dolomite is rarely, if ever, used in the manufacture of brick at the present time because of the difficulty encountered in preventing the lime from slaking. Several years ago Dolomite brick were made at different European steel plants but as it was necessary to use them immediately in order to prevent their disintegration they were gradually replaced by magnesia brick.

The use of dolomite in patching and, in a few cases, for building entire bottoms has continued to the present day, probably because of its low initial cost as compared with that of magnesite. Dolomites highest in magnesia and containing about 4 per cent iron oxide and alumina, apparently have the most desirable characteristics. When over 4 per cent iron oxide and alumina is present, especially when accompanied by more than 3 or 4 per cent silica, the product is less refractory. The writer has compared burned dolomites, with treated dolomites and dead burned magnesites and finds that magnesites are more resistant to slaking than dolomites or dolomite preparations.

Chrome brick have certain desirable characteristics but are rarely used in electric furnaces. They are favored by a high thermal conductivity, fusion point, and resistance to slagging action. On the other hand, they are difficult to bond, while the chromic oxide may be reduced to chromium, and contaminate the metal being melted.

The use of a layer of chrome brick or chrome ore has proved to be a satisfactory method of separating silica and magnesia brick in order to prevent their interaction at high temperatures. It is possible that chrome, because of its insolubility, might be utilized at the slag line either by itself or in conjunction with magnesite. The successful use of chrome might greatly increase the resistance of the lining to the action of the slag which dissolves the magnesite or dolomite so rapidly.

As far as the writer is aware few zirconia brick, if any, are being used in electric furnaces, although several investigators believe that their use will solve many problems. These opinions are based upon the high fusion point of the pure material, the low conductivity of the brick, and their marked resistance to the solvent action of certain fluxes.

There are numerous commercial disadvantages however, which must be overcome before the full refractory value of zirconite is developed. The mineral is often badly contaminated with iron oxide and as a result its fusion point is seriously lowered. It also undergoes considerable shrinkage at high temperatures and, therefore, must be given a severe heat treatment before installation, in order to prevent shrinkage in service.

TABLE II

Resistivity in Ohms Per Cubic Centimeters

Temperature Degrees Cent.	Magnesia Brick	Chrome Brick	Silica Brick	Fire Brick	Carborundum	Alundum*
528	.....	.....	.....	.....	....	130
600	.....	.....	.....	21,000	14.6	...
700	.....	.....	.....	17,000	10.9	16 (730° C)
800	.....	2,800	.....	13,000	7.8	...
900	.....	760	.....	9,000	5.4	5.3 (892° C)
1000	.....	420	.....	6 600	3.7	1.8 (1020° C)
1100	.....	430	.....	4.400	2.1	...
1200	.....	450	.....	2,300	1.3	...
1300	5,200	410	9,700	1,300	.96	...
1400	420	320	2,400	690	.65	...
1500	55	.....	710	280	.....	...
1550	30	.....	22	60	....	...
1565	25	.....	18	.....	....	...

*Megohms.

Bearing in mind that the influence of impurities and of the incomplete removal of shrinkage will be accelerated by the low thermal conductivity of the brick, it is evident that three things must be accomplished before the full value of zirconite as an electric furnace refractory is realized.

Raw material of the necessary purity must be available, either by proper sorting or purification.

It must be bonded into a mechanically strong brick.

This brick should undergo little shrinkage after being installed.

If these three things can be accomplished there is little question but that the product would give satisfactory service in certain positions, with a reduced consumption of fuel. Little is published regarding the use of zirconia in binding up furnace bottoms. When its high fusion point and insolubility is considered this possibility is not remote.

Bauxite Requires Heat Treatment

Bauxite brick have characteristics much the same as those made from zirconite, a fact which is not surprising because of the similarity in behavior of the dominating oxides found in each. In order to secure the full value of bauxite as an electric furnace refractory it is necessary to subject the brick to an intense heat treatment in order to completely remove the shrinkage. Bauxite brick do not possess the advantage of having a high thermal conductivity.

Carborundum and alundum offer good possibilities for service in roofs as they have all of the assets of silica brick, with the additional advantage to a low tendency to spall. Their fusion points are high as is the thermal conductivity. Their tendency to shrink is naturally low, and they can support a heavy load at high temperatures. The writer is unable to state to what extent they are affected by furnace gases, or slag. In a few cases oxidation of the silicon carbide to silica, resulting in the weakening of the brick structure, has been reported. It is probable that the practice of insulating bricks of this type could be practiced with greater safety than with other types, because of their higher fusion points and low shrinkage.

Shrinkage in Castings

Question—I am a steel molder and looking over the castings I find many small holes or dents and I would appreciate any information about the cause and prevention of these holes.

Answer—Holes on the surface of steel castings generally are due to one of three reasons: Either an improperly dried mold, oxidized metal or shrinkage. The first two causes produce more of a honeycombed or pin hole effect. Shrinkage would leave an indentation in the metal. From your description we judge that the trouble you are having is from shrinkage as you say the castings are dented. The way to overcome it is through proper feeding or by chilling. Feeding may be done by adding a sinkhead at the proper place, or the same effect sometimes may be accomplished by changing the gating. In a few cases chills are of benefit.

TABLE III

Data on Thermal Properties

Material	point	Point of failure sq. inch load	Thermal at 1000°C.	at 100°C.	to spalling
Fireclay	1700°C.	1350°-1400°C.	.0039	.199	Good
Silica	1700°C.	1600°C.	.0044	.219	Poor
Magnesia	2165°C.	1480°C.	.0079	.231	Poor
Chrome	2050°C.	1425°C.	.0057	....	Poor
Bauxite	1785°C.	1350°C. or more	Same as fireclay	....	Good
Zirconia	2575°C.	1510°C.	Low	....	....
Carborundum	2240°C.	Above 1650°C.	.0231	.198	Good
Alundum	2050°C.	.....	High	.186	Good

Sometimes heavy sections are chilled by casting the metal around pieces of steel, known as internal chills. At other times pieces of steel are placed in the face of the mold and covered with a silica wash to prevent the metal of the mold from fusing to them. Such chills are used on heavy sections which join lighter sections.

Safety Core Room Is Served by Elevator

PRACTICAL elevating and conveying systems installed in the new core building recently erected by the Chain Belt Co., Milwaukee, are a considerable factor in promoting tidiness of operation as well as speed and efficiency. The core room is on the third floor of a 3-story building and it is claimed that owing to the elevating and conveying equipment the arrangement is more advantageous than the usual ground floor layout. Each floor has an area of 4500 square feet. The first floor is used exclusively for pattern and core storage. The second floor houses the metal pattern shop and the third floor is devoted altogether to coremaking.

An enclosed bucket elevator 55 feet high and provided with 6-inch buckets on every tenth link carries the sand from the mixing department in the sand shed to the core room on the third floor. The capacity of the elevator is adequate for the requirements of the core room. Sand is wheeled in a barrow as shown in Fig. 1 from the shed to the boot of the elevator into which it is dumped. At the top of the elevator the buckets discharge the sand into a flexible spout 12 inches in diameter and 10 feet long. From the spout the sand passes into a trolley bucket conveyor which travels over a long platform and unloads into a number of hoppers feeding the work benches.

Trolley buckets eliminate a number of operations in the core room usually performed by manual labor. They are employed to carry the cores from the bench to the oven. After the cores are dried they are again put back in the buckets and taken to the inspection department. After the cores have been inspected they are taken down two stories in the lowerator shown in Fig. 2, to the core storage room.

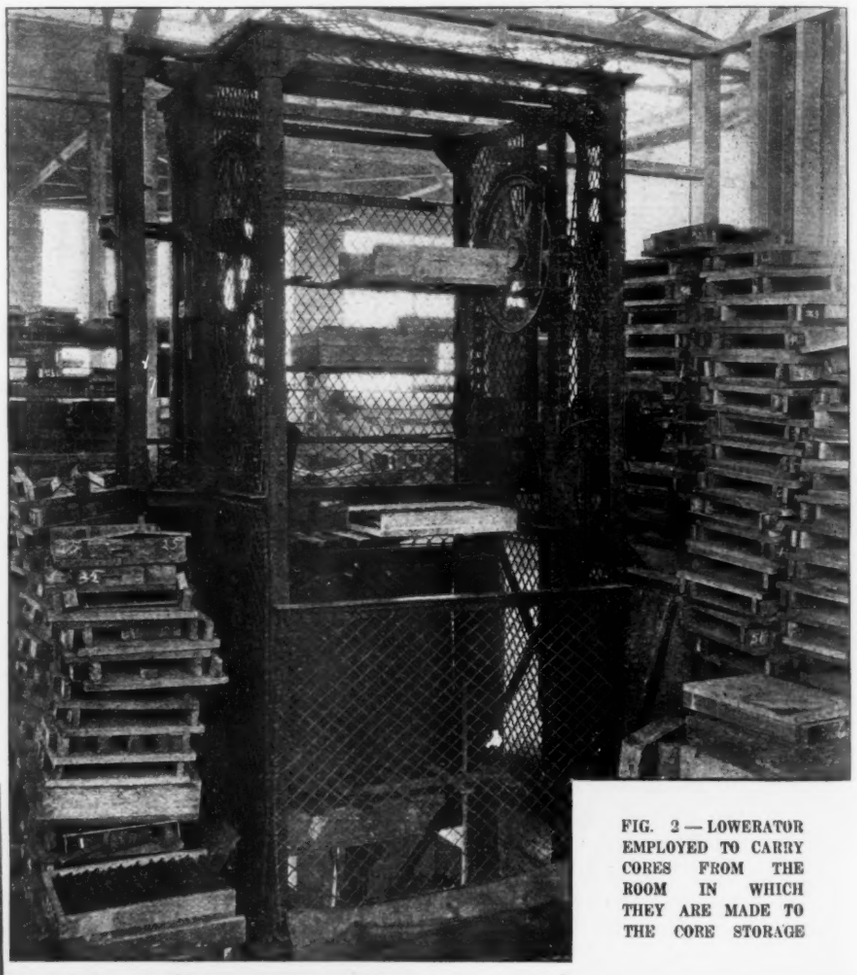


FIG. 2—LOWERATOR EMPLOYED TO CARRY CORES FROM THE ROOM IN WHICH THEY ARE MADE TO THE CORE STORAGE

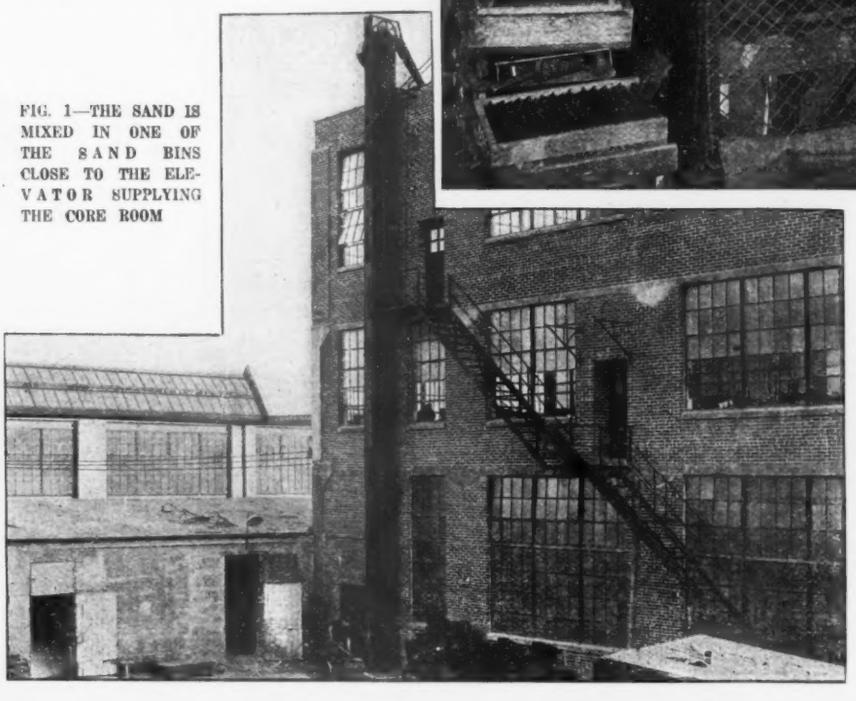


FIG. 1—THE SAND IS MIXED IN ONE OF THE SAND BINS CLOSE TO THE ELEVATOR SUPPLYING THE CORE ROOM

The lowerator is located at the extreme end of the inspection room and since it is the only passage through which the cores can pass to the storage room the chances of defective cores slipping through are reduced to a minimum. On its return journey the lowerator is employed to carry patterns and coreboxes up from the pattern shop. Nine ovens altogether are in use in this latest addition to the plant of the Chain Belt Co. The building is of brick and steel construction of modern factory type which insures adequate lighting and ventilating facilities.

How Treatments Affect Gear Bronze

Microscopic Views Show Structure of Chill-cast Metal to Be Uniform—Sand-cast Metal Thought to Have Better Bearing Qualities—Elongation of the Alloy Increased by Annealing

BY AUSTIN B. WILSON

FOR the subject of this paper the writer has selected a type of bronze commonly employed in this country for worm wheels on motor trucks where service conditions are severe and quiet running a desired feature. It is known as Stone's English gear bronze. Its composition is approximately tin, 11.0 per cent; phosphorus, 0.3 per cent, and the balance copper. Little variation in this composition should be allowed. It should be used against nicely finished high carbon or alloyed steels.

The average physical properties of this material are given below. Any metal falling below the minimum given should be rejected as unsatisfactory.

Yield point, lbs. per sq. in.	22-25,000
Maximum strength, lbs. per sq. in.	35-40,000
Elongation, per cent in 2 in.	6-10.0
Reduction of area, per cent	7-9.0
Specific gravity at 20 degrees Cent.	8.5
Brinell hardness	80
Patternmaker's allowance for shrinkage, in. per foot	.125
Weight per cu. in., lbs.	.31
Elastic limit in compression, lbs. per sq. in.	16,000

With a few exceptions the photomicrographs used to illustrate this paper were all made from metal of the above composition. In the few exceptions they were made from the material known as *composition G*, which contains 88 per cent copper, 10 per cent tin and 2 per cent zinc. The microstructures of the two alloys are almost identical, but the *G* metal contains somewhat less of the copper-tin eutectoid.

It here would be well to consider briefly the diagram of thermal equilibrium for the copper-tin alloys which is shown in Fig. 1.

An alloy of this composition, 89.0 per cent copper and 11.0 per cent tin—is completely molten at any point above

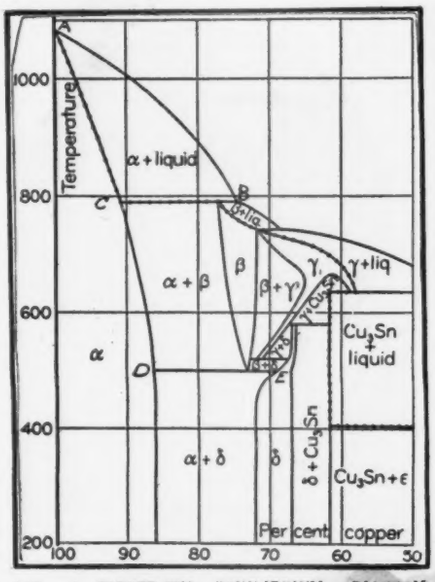


FIG. 1—COPPER-TIN EQUILIBRIUM DIAGRAM AFTER SHEPHERD & BLOUGH, JOURN. PHY. CHEM., 1906, VOL. X

the curved liquidus line *AB*. As the temperature on cooling falls, a point is reached at which it intersects the line *AB*. At this point the process known as *selective freezing* commences. This continues until the temperature represented by the line *CB* is reached during which time the metal is partly in the solid and partly in the molten condition. It consists at this time of growing primary alpha crystals and a residual liquor of higher tin content than the metal already solidified. The metal first to solidify is of low tin content and forms the center of the alpha crystals. The balance of the metal freezes in concentric layers each slightly higher in tin content than the preceding one. This variation of composition within the crystal gives rise on etching to the famliar *cored* structure typical of these bronzes. When the line *CB* is reached the liquor solidifies and appears as another constituent known as *beta*. On further cooling this *beta* constituent is transformed at approximately 500 degrees Cent., the line *DE*, into a mixture known as the eutectoid. This eutectoid is composed of saturated alpha and a hard, brittle, metallic compound, Cu_4Sn, known as *delta*. Owing to the presence of delta constituent the eutectoid is much harder than the other parts of this alloy.

This explanation shows the results obtained with this alloy in ordinary commercial foundry practice and not under conditions in which equilibrium is contained. If the cooling were ideally slow, diffusion would take place, the alpha crystals would be of uniform composition throughout and the eutectoid would disappear, only polygonal crystals of alpha solid-solution remaining. Fig. 2 shows a piece of gear in which this condition was obtained by long annealing. The fine parallel bands are slip-bands caused by strain. Fig. 3

The author, Austin B. Wilson, is metallographist, the Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

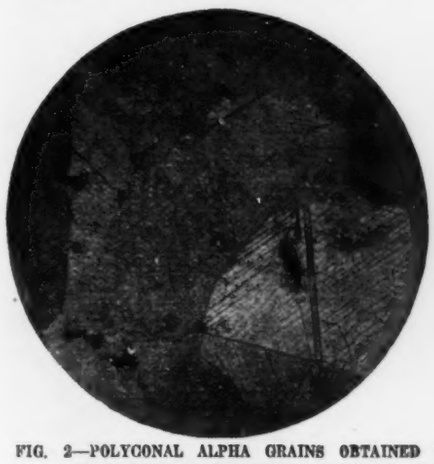


FIG. 2—POLYGONAL ALPHA GRAINS OBTAINED BY LONG ANNEALING—X 100 DIA. FIG. 3—UNDECOMPOSED BETA BETWEEN THE ALPHA GRAINS, PRESERVED BY QUENCHING FROM 100 DEGREES CENT.—X 100 DIA. FIG. 4—TYPICAL SAND-CAST ALLOY SHOWING SOFT ALPHA CORES SURROUNDED BY DARK OUTLINES, SMOOTH SATURATED ALPHA AND SKELETON-LIKE EUTECTOID AREAS—X 200 DIA.—ALL ETCHED WITH NH_4OH AND H_2O_2

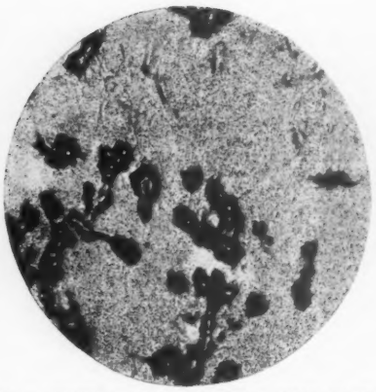


FIG. 5—SAME AS FIG. 4 EXCEPT THAT IT WAS DULL-CAST

FIG. 6—TIN-SWEAT ETCHED WITH NH_4OH AND H_2O_2—X 200 DIA.

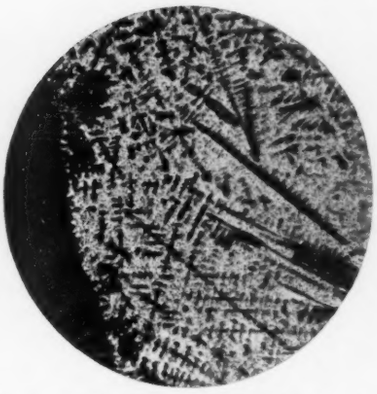


FIG. 7—"HARD SPOT"—LIGHT PART IS HARD SPOT—X 20 DIA.

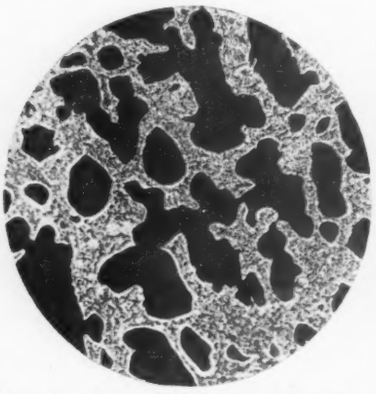


FIG. 8—"HARD SPOT"—METAL IS HIGH IN EUTECTOID—X 200 DIA.

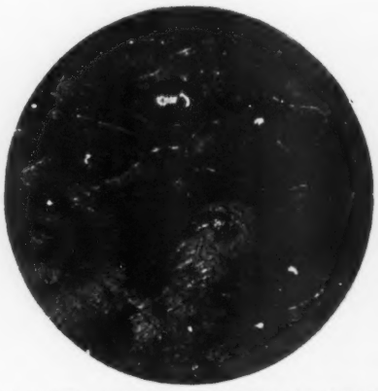


FIG. 9—THE TYPICAL STRUCTURE OF CHILLED METAL—X 200 DIA.

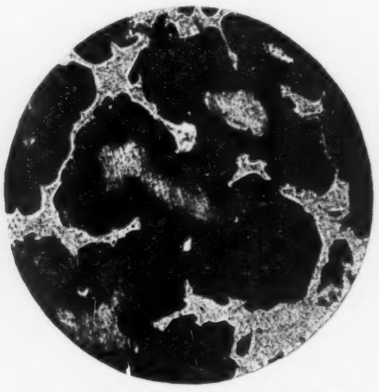


FIG. 10—TYPICAL SAND-CAST STRUCTURE—X 200 DIA.

FIG. 11—ONE MM. BELOW SURFACE OF TOOTH OF SAND-CAST GEAR—X 100 DIA.

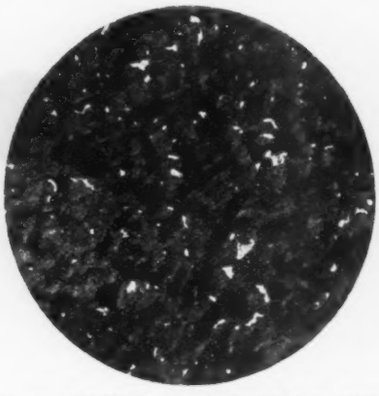


FIG. 12—STRUCTURE AT SAME POINT IN CHILL-CAST GEAR CORRESPONDING TO FIG. 11

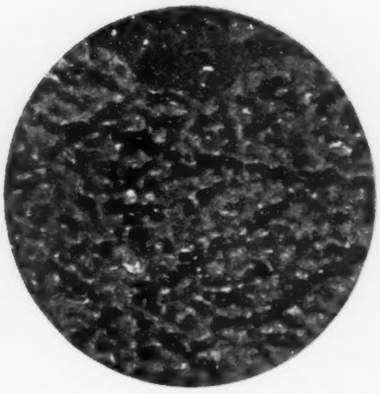


FIG. 13—APEX OF TOOTH OF CHILL-CAST GEAR BLANK—X 100 DIA.

FIG. 14—SAME AS FIG. 13 AT BASE OF TOOTH —X 100 DIA.

FIG. 15—DENDRITIC STRUCTURE OF CHILL-CAST GEAR—X 20 DIA.

FIG. 16—ALLOY AS CAST—EUTECTOID AND SHARPLY DEFINED CORES—X 200 DIA.

FIG. 17—SAME AS FIG. 16 AFTER HEATING TO 600 DEGREES CENT.—TRACES OF EUTECTOID AND CORES LESS SHARPLY DEFINED—X 200 DIA.

shows a specimen in which the beta had been preserved by quenching from a high temperature, thus preventing the formation of the eutectoid structure. Fig. 4 is typical of this alloy when cast in sand. The sample was etched with ammonia and hydrogen peroxide. It shows the crystal cores, low in tin, as spots heavily outlined in black due to the attack of the etching reagent which was eating them away until they are lower than the surface of the rest of the metal. These cores are surrounded by a smooth substance, ordinary alpha, and the rough eutectoid is between the alpha crystals. Under the microscope the eutectoid appears blue and the alpha yellow, the difference being much more distinct than in the colorless illustration.

When this alloy is chill-cast a much finer structure with less eutectoid is produced. The chill mold causes the metal to freeze more quickly thus allowing less opportunity for the occurrence of selective freezing. In addition solidification starts simultaneously at so many points that the metal sets almost immediately. Thus very little of the beta and consequent eutectoid can form. Fig. 5 illustrates this showing very few cores, indicative of selective freezing, and only traces of eutectoid. This micrograph was taken close to the chilled surface of a gear. When such a gear is properly chill-cast the resultant hardness erly chill-cast the resultant hardness is greater than that of one which has been sand-cast, despite the absence of the hard eutectoid from the former. Evidently the lack of the hard constituent is more than made up for by the finer grain, smaller amount of soft cores and greater soundness obtained through chilling. Moreover, by this method the metal is rendered far more uniform and much less liable to contain hard spots. Therefore, it is plain that the machining qualities of the alloy must be superior when it is chill-cast to when it is sand-cast.

A phenomenon with which all foundrymen are familiar might well be mentioned here. This is known as *tin-sweat* or liquation. It sometimes happens that during solidification i. e., while some of the metal is solid and some liquid, a silvery substance will ooze up through the riser in globules after the casting is to all appearances

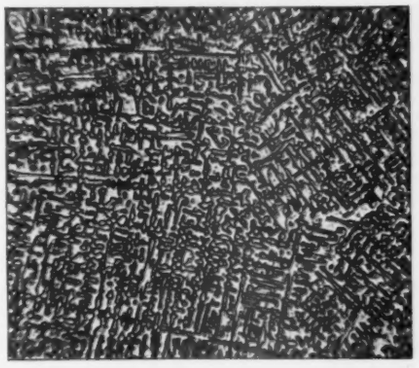


FIG. 19—SAME AS FIG. 16—X 20 DIA.

solid. This metal is hard, brittle and high in phosphorus and tin, containing approximately 22 per cent of tin, and consisting almost entirely of crystals of Cu_4Sn with some alpha solid solution and some Cu_3P. It has a brinell hardness of about 240. Fig. 6 is a micrograph of such a spot, etched with ammonia and peroxide.

A good example of hard spots in this class of material was recently found in a chilled gear. The spots could be easily seen after machining as they were a bluish-gray while the remaining metal was yellow. After etching it was seen that some of these spots extended to a depth of an eighth inch and the boundaries between them and the rest of the metal were very sharply defined. The metal below the spots had the usual chilled structure of numerous small, cored alpha grains and fine particles of eutectoid widely scattered. This gear had evidently been properly chilled even on the face in which the hard spots were found to exist. Fig. 7, 8

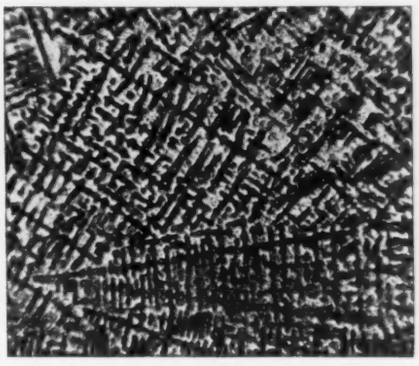


FIG. 20—SAME AS FIG. 17—X 20 DIA.

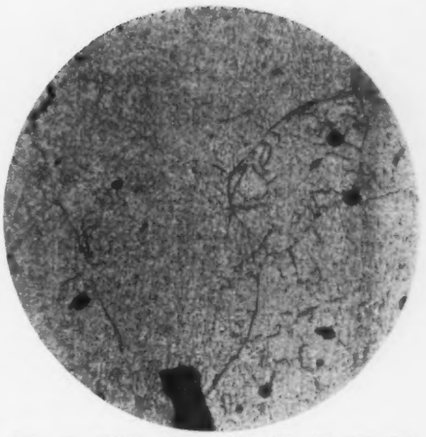


FIG. 18—SAME AFTER HEATING TO 800 DEGREES CENT. SHOWING POLYGONAL ALPHA GRAINS AND NUMEROUS CAVITIES BUT NO EUTECTOID OR CORES—X 200 DIA.

and 9 illustrate the microstructures found. Fig. 10, a sand-cast gear, similarly etched, is shown for comparison.

The method followed in preparing these four micrographs was to follow the ammonia and peroxide etch by a short etching with acidified ferric chloride which darkens the alpha crystals very strongly and leaves the eutectoid bright and unattacked. The micrographs thus obtained made the difference between the alpha and eutectoid much more distinct than those in which the ammonia and peroxide etch alone was used.

Three castings intended to be finished into the same type of worm wheel were cast from the same heat of metal which analyzed 88.7 per cent copper, 10.96 per cent tin and 0.39 per cent phosphorus. One with teeth formed in it was cast in a chill. A similar one was cast in sand and the third was cast in an ordinary black chill mold. Tensile tests showed the metal to be of satisfactory quality as did the fractures of cross-sections of the gears themselves. Brinell tests on cross-sections of the teeth, at points which in the finished gears would correspond with each other, showed very little variation although the surface of the chilled tooth was slightly harder and the interior of the

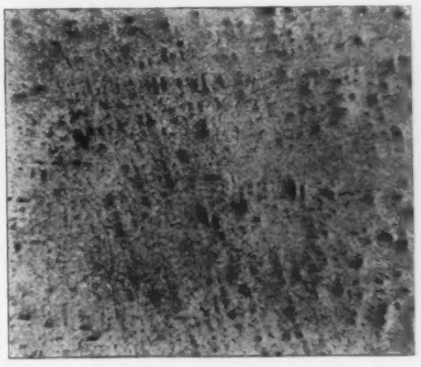


FIG. 21—SAME AS FIG. 18—X 20 DIA.

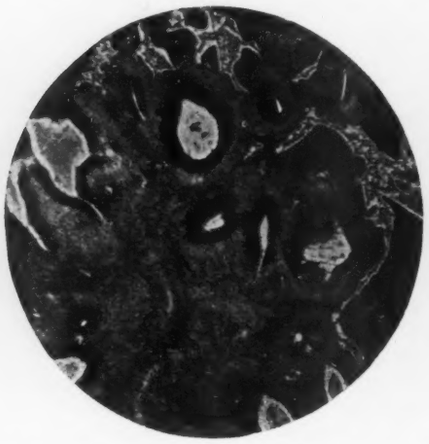


FIG. 22 SLIP BANDS NEAR BEARING SURFACE OF WORM-GEAR TOOTH - ETCHED WITH NH_4OH AND H_2O_2—X 100 DIA. FIG. 23—OXIDE FILMS—ETCHED WITH NH_4OH AND H_2O_2 FOLLOWED BY $FeCl_3$—X 200 DIA. FIG. 24 —PHOSPHORUS SEGREGATION IN PHOSPHOR BRONZE—X 400 DIA.

sand-cast slightly softer than the average. The slight loss in hardness at the center of the sand-cast gear was due, doubtless, to a less sound condition of the metal.

Figs. 11 and 12 show the structure found on a line parallel to and one millimeter below the surface of the sand-cast and chill-cast gears with teeth, respectively. The microstructure at points which would correspond in the chill-cast gear blank showed considerable variation. Figs. 13 and 14 show the structure as found at points which in the finished gear would be near the apex and base, respectively, of the tooth. The average structure would be intermediate between these.

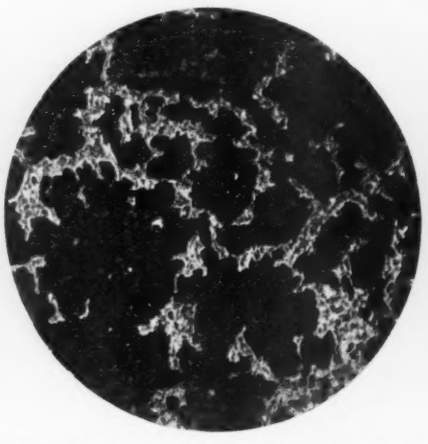
From the illustrations it will be seen that the sand-cast material would probably have the better bearing qualities as it has an important feature of a good bearing metal which the chill-cast lacks.

In order to secure satisfactory bearing qualities an alloy must be composed of particles of a hard constituent embedded in a matrix of softer material. Although these particles should not be so hard as to cause a marked abrasive action on the journal, still they must be hard enough to support the load and resist the wear. The softer and more ductile material prevents brittleness in the bearing and being more plastic permits the bearing to flow around the journal and so adjust itself to the journal surface. In addition, the wearing away of this softer constituent causes the formation of shallow depressions between the harder particles. The oil is retained in these shallow depressions and prevents scoring or seizing when the journal is starting from a state of rest. This lubricating action is the most important characteristic of a bearing alloy and has led the committee on Bearing Metals of the American Society of Mechanical Engineers to define a true bearing metal as: "An alloy that is capable of retaining a lubricant on a bearing surface."

The chill-cast alloy, although hard, is too uniform to have good bearing properties. Some rolling abrasion tests made in this laboratory bear out this statement more or less. For ease in machining, however, the chill-cast is far superior. It lacks the hard spots due to the presence of the eutectoid in large particles. In addition, it is difficult to cast large cross-sections of this metal and produce sound castings without chilling. Experience in each individual case alone will tell whether the sand-cast has the necessary toughness to resist shock and vibration. Even tests on small bars in which the sand-cast must have been comparatively sound indicate that the chill-cast is superior in shock resistance.

Fig. 15 shows the typical chill-cast structure and is included for comparison with the sand-cast sample which is shown in Fig. 19.

Sand-cast alloys of this type may be greatly improved by annealing for at least 30 minutes at any temperature from 600 to 800 degrees Cent., followed by slow cooling. The yield point and hardness are little affected but the other properties, especially the elongation, are decidedly benefitted although this treatment does not improve the soundness of the metal in the slightest. The alloy will not



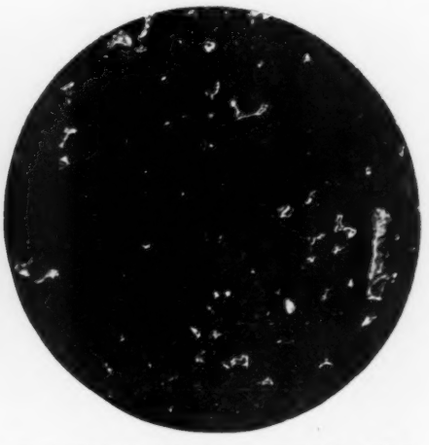


FIG. 25—STRUCTURE OF CENTRIFUGAL-CAST GEAR—ETCHED WITH NH_4OH AND H_2O_2—X20 DIA. FIG. 26—STRUCTURE OF LIGHTER STREAKS, SHOWN IN FIG. 25, AFTER ETCHING WITH NH_4OH AND H_2O_2—X 20 DIA. FIG. 27—STRUCTURE OF DARKER STREAKS SHOWN IN FIG. 25 AFTER ETCHING AS IN FIG. 26—X 200 DIA.

stand the effects of quenching, quenched bars developing cracks when subjected to low tensile stresses. Figs. 16 to 21 illustrate the structures obtained by annealing.

The good results in tensile tests from the bars treated at 800 degrees Cent. were rather surprising in view of the number of holes in the metal. It was suggested by George F. Comstock that "in the metal as cast, the inclusion of gas are in the form of films between the dendritic crystals, and the films are so thin that though affecting the cohesion of the metal adversely, they are not conspicuous on a polished section. When the crystals are changed from the dendritic to the polygonal form by the anneal, the gas films tend to contract owing to the force of surface tension, and to form more rounded cavities. These are conspicuous on a polished section, but do not interrupt the continuity of the metal as much as the thinner films and hence allow a bar to show more strength and elongation when tested."

The remaining mircographs are included merely for the purpose of showing to the reader the microscopic appearance of this alloy in a few of the conditions met with by the metallographist. Fig. 22 was taken just under the bearing surface of a gear which had been in service. It shows slip-bands induced by the strain caused by the pressure of the worm on the bearing surface. The typical cored structure of this alloy is plainly seen. The black irregular lines are the grain boundaries, and the numerous fine, straight, intersecting black lines are the slip-bands.

Fig. 23 shows oxide films at a particularly unsound spot. The light rounded areas denote the crystal cores, the light skeleton-like areas indicate the eutectoid, and the irregular black lines are the films of oxide. In the eutectoid the delta appears as a white groundmass in which are embedded grayish alpha particles.

Fig. 24 illustrates an example of phosphorus segregation in this alloy. The phosphide Cu_3P which contains 14 per cent phosphorus by weight is shown as a grayish substance against a lighter groundmass. It always occurs in connection with the eutectoid areas and is readily distinguished from the eutectoid in unetched sections by darker color of the phosphide. In etched sections it is indistinguishable from the eutectoid. The area shown is one in which segregation is present to an unusual extent.

Fig. 25 shows the structure of a centrifugally cast gear. Note the bands of alternate light and dark. These bands were found throughout, running in concentric layers. The difference in the microstructure of these layers is shown in Figs. 26 and 27. Fig. 26 shows the structure of the lighter band and Fig. 27 that of the darker. It will be readily seen that the difference is caused by a great variation in the amount of eutectoid present. The amount of eutectoid in Fig. 26 is even more than that usually found in sand-cast gears, while that in Fig. 27 approximates that found in chill-cast gears. The grain size throughout was the finest the writer has seen in material of this class and the metal was exceptionally sound. The fineness of the grain can readily be accounted for as the metal was in a state of violent agitation up to the moment of solidification, thus causing freezing to start simultaneously at innumerable nuclei, but no reason can as yet be put forward for variation in euectoid amount.

How and Why in Brass Founding

By Charles Vickers

Lead-Copper Alloys

We are about to undertake casting an alloy of 50 per cent lead, 50 per cent copper, and wish information in regard to the best method of melting the conditions under which the metal should be poured to avoid segregation of the lead. Also advise as to the best flux to use to insure sound castings free from spots of oxidation in the fracture. We also would like to learn what effect phosphorus would have as a deoxidizing agent.

In making alloys it is a rule that the metal of highest melting point be melted first. In this case melt the copper, and add the lead afterwards with a thorough stirring to incorporate the same. As a flux, plaster of paris and borax is used, adding about 2 per cent, one-half of which is placed in the furnace with the cold metal, and the other half is added after the copper is melted, and just before the lead is added. To hold the lead in solution it is customary to add from 0.25 to 0.5 per cent of roll sulphur, this addition being made after the metal is mixed, and before removal from the furnace. Phosphorus should not be used in connection with this metal, as it will throw down the lead, precipitating it to the bottom of the castings. To produce this metal so the fractured surfaces do not contain spots of differently colored metal, usually reddish, requires skillful handling in the furnace, also a knowledge of pouring temperatures and molding gained only by experimenting.

Preventing Segregation of Metals in Alloys

We are sending you a small sample of bronze broken to show the fracture, which contains large reddish and orange colored spots which cause the metal to appear unhomogenous. We would thank you to advise us whether you consider this metal has been properly mixed. The constituents are copper, tin, phosphorus, spelter and lead. We would also like a formula for a casting that would withstand a pressure of 75 tons per square inch, these castings to be made into dies for pressing soft material.

An inspection of the sample submitted shows it to be a high tin alloy and the spotted appearance of the fracture is not due to improper mixing of the metal; that is no amount of stirring would have made any difference in its structure after it solidified. The alloy itself is at fault, it is one of those alloys, and there are many of them, that might be said to unscramble itself after solidification, and the cause is either too much zinc for the percentage of tin, or too high phosphorus. For instance an alloy of 12 per cent tin, 6 per cent zinc, 82 per cent copper, has too much zinc for the percentage of tin. Castings always will show this blotched fracture and to avoid this the zinc content must be reduced to an amount under 3 per cent. With a metal that would otherwise be homogenous in fracture, the introduction of too large an amount of any deoxidizer such as phosphorus, manganese or combinations of these will produce the condition shown in the sample. In the

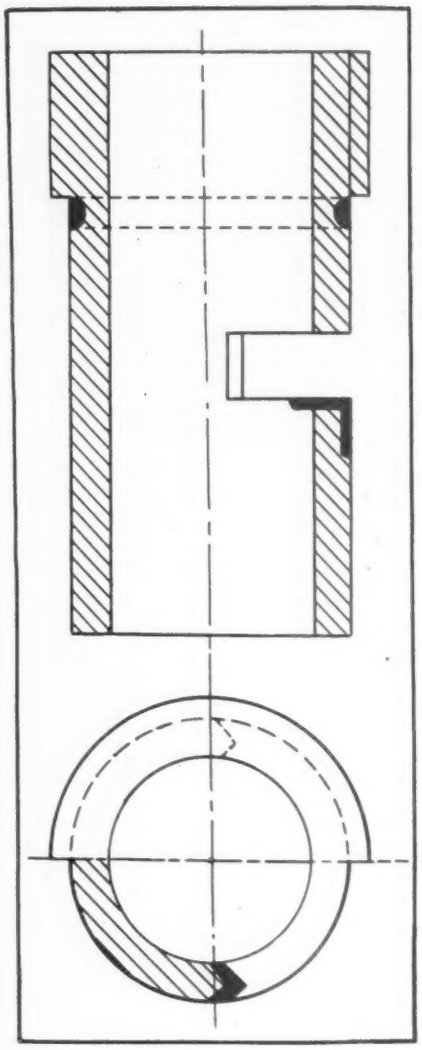


FIG. 1—PLAN AND SECTION OF CHILL-CAST BEARING

absence of an analysis we are unable to state whether the blotches are due to high zinc or high phosphorus, but if the tin is above 12 per cent, keep both zinc and phosphorus low, say 2 per cent zinc and 2 ounces of 15 per cent phosphor copper per 100 pounds of metal.

Some alloys are susceptible to the disturbing influence of the so-called deoxidizers, and in general it may be said that all alloys that contain a substantial amount of all the white metals, tin, zinc, and lead will have their structure changed unfavorably by the addition of excessive amounts of deoxidizers. It makes little difference whether tin, or zinc, predominate in the mixture. Red brasses are spoiled just as easily as the high tin alloys; thus an alloy containing 11 per cent zinc, 4 per cent lead, 2 per cent tin will have a close, uniform fracture. The addition of as little as 0.25 per cent of 15 per cent phosphor copper will produce a mixed fracture, and a metal with such a fracture will leak under pressures. Other deoxidizers produce a similar effect. In general when the tin or zinc is high, as they can be in a bronze or a red brass, little deoxidizer should be added if homogeneous alloys are wanted. When zinc is absent and lead takes its place, it is different; thus an alloy of tin 12 per cent, lead 6 per cent, copper 81 per cent, is made with 1 per cent phosphorus.

An alloy frequently used for dies is the following: Copper, 85.50 per cent, tin, 14.50 per cent, aluminum 2 ounces per hundred pounds of the alloy. The aluminum acts as a deoxidizer, also improves the fluidity of the alloy. Another alloy consists of copper 85 per cent; iron, 5 per cent and aluminum 10 per cent.

Chill-Cast Bearings

We have been casting small bearings in chills, but do not get results that are satisfactory. The castings are not sharp on the edges, and show suction cavities in the corner where the body and the flange of the casting meet as shown in Fig. 1. *The bearing is the bushing type with a flange on one end, and a slotted opening in the body with the bushing. The alloy consists of copper,* 81.50 *per cent; tin,* 8 *per cent; phosphor copper,* 0.5 *per cent. The bearing is cast upright in a mold of cast iron with a ground steel core, and the gate connects at the bottom of the casting as shown in Fig.* 2. *We will appreciate any suggestions you may have to offer.*

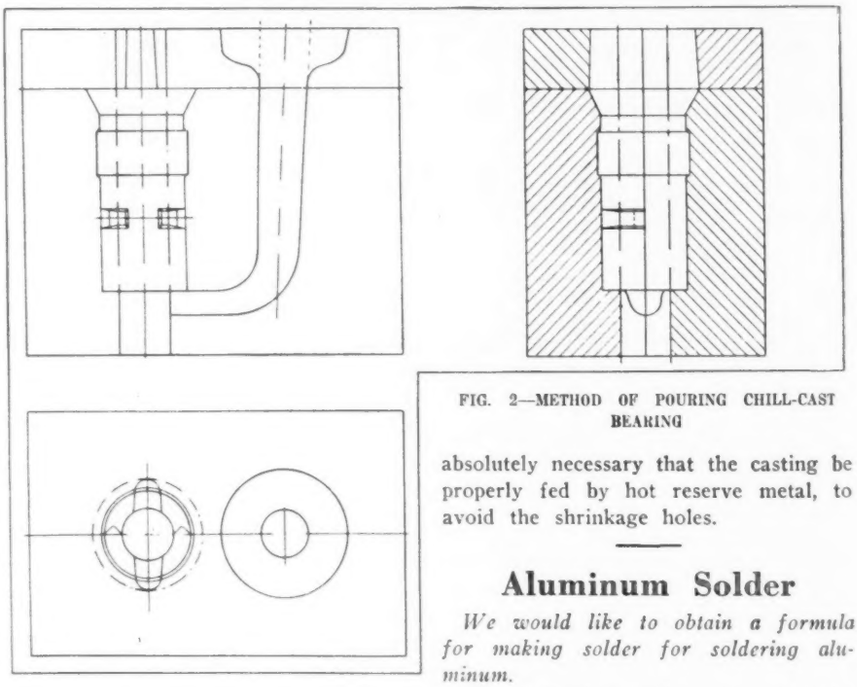


FIG. 2—METHOD OF POURING CHILL-CAST BEARING

The reason the castings fail to run sharp is that the mold is too cool and solidifies the metal before it can fill out the corners. The molds can be worked hot provided they are operated by a die casting machine, the latter being a device that firmly holds the two halves of the mold in line and by means of suitable levers and slides permits the mold to be closed and opened with speed and certainty. A small amount of aluminum added to the metal will aid in filling the castings sharply. About 2 ounces of aluminum per hundred pounds of bronze should be used. As the alloy contains no lead, it is not any better as a bearing metal than a 10 per cent aluminum bronze and the latter alloy would run much cleaner and sharper castings. The shrinkage is due to the fact that the risers congeal at the same time as the casting itself. Therefore, they cannot supply metal to fill the voids caused by shrinkage. The risers should be insulated from the body of the die, which can be done readily by using a core to carry the risers. To avoid dropping grains of sand into the mold from the core, the core should be made of sharp sand bonded by silicate of soda. As the core is not enclosed by metal, the fact of its being as hard as rock will have no significance. It is absolutely necessary that the casting be properly fed by hot reserve metal, to avoid the shrinkage holes.

Aluminum Solder

We would like to obtain a formula for making solder for soldering aluminum.

The following makes a good aluminum solder: Tin, 78 per cent; zinc, 8 per cent; aluminum, 9 per cent; cadmium, 5 per cent. Another solder extensively used is made as follows: Tin, 63 per cent; zinc, 37 per cent; aluminum, 1 per cent.

Pattern Brass Alloy

We would like to obtain a mixture of metal suitable for brass patterns.

The following alloy is suitable for metal patterns: Copper, 86.50 per cent; tin, 5 per cent; lead, 5 per cent; zinc, 3.50 per cent.

Judging Sands for Foundry Use–IV

Careful Comparison of Molding Sands May Enable Foundrymen to Adopt Material from Adjacent Pits to His Specialized Requirements—Artificial Treatments Described

BY HENRY B. HANLEY AND HERBERT R. SIMONDS

IN the previous articles which have appeared on sand in the present series it has been the intention to cover in considerable detail the methods employed in determining the nature of sands. However it is one thing to know how to test a sand and another to utilize such a test properly.

In the first paper, the definite uses of sands in a foundry were enumerated together with the characteristics of those sands which more closely suited each different purpose. A sand for instance with certain bond and grain properties was found to be well adapted to stove plate work, whereas another with different properties was seen to better meet the requirements of heavy castings. Sand from different territories vary in the fundamental characteristics of bond, grain size, and refractoriness, so that a thorough knowledge of the different sands occurring in nature makes it possible for the foundryman to suit nearly every demand of his work. However, he must be willing to pay a high price it he intends always to get the sand which he knows possesses the right characteristics. The question of sand economy is an important one in almost any foundry and it is this question more than anything else which has led to the exhaustive study and research of the molding sand question. It was pointed out in the first article that much could be done in the way of altering natural sands by artificial means. In this way sands may be used, which, though not entirely meeting the foundryman's requirements, are found in the vicinity of his plant and are therefore obtainable at low cost.

The loss of castings looms up so great in comparison with the cost of sand in a foundry that there is a strong tendency for a plant manager to say, "Yes, our sand is costing us a great deal but we are losing less than 5 per cent of our castings and so we cannot afford to experiment with sand and run the chance of heavier casting loss." Too, there is the labor side to consider. Men who are working on a piecework basis demand that the same sand to which they have become accustomed be continued. In fact, in some cases, labor troubles have been caused solely through the change of foundry sand. The question arising, therefore, is how may sand modification be made. It requires four things.

The knowledge of what is required in a sand for the purpose intended.

Information concerning a low cost, nearby sand, which most closely meets these requirements.

Exact knowledge of the substance which must be added to the low price sand to make it come up in all respects to the foundry practice requirements.

The use of a great deal of tact and common sense in adopting new sand.

Some idea of what is meant by these four items may best be shown by taking an actual case where a high price sand was replaced in a foundry by an artificially altered low price sand. A New England medium-casting foundry had been accustomed to use a natural sand shipped in at a freight rate of nearly $4 a ton with a fairly high pit cost. The sand problem came under the direction of a superintendent who knew the possibilities of using low price sands, and who therefore set about making a survey of the nearby territory. After obtaining and testing samples from several pits, he finally hit upon one which almost exactly suited his requirements as to grain size. This is the first thing to consider, as grain size is the hardest to alter if it is not found of suitable size in nature. In fact, in this country alteration of grain size either by sifting or mulling is rarely attempted, though in Europe, in some cases selection of grain size for special castings is made. Having secured a sand of the proper grain size the next important question is uniformity in the pit. That is, the chance of securing a continuous and uniform supply over a period of at least several years. If these two features are satisfied, little else is required, for the entire bond often may be economically added for sands with little or no original bond and which therefore may be had at a correspondingly low pit cost. In the case of the New England foundry referred to, the sand found by the superintendent was located within a short distance of the foundry and the pit showed on investigation to have sufficient size and uniformity to warrant experimental work. An analysis of this sand was made and gave the following result as to grain size.

Number of wires per inch in sieve	Percentage of sample left on sieve
20	1
40	2
60	3
80	15
100	34
150	31
200	2
200 plus	2
Bonding substance	10

This will be recognized as excellently sized sand as 80 per cent falls between the 80 and 150 sieves.

The bond absorption test of the natural sand as it came from the pit was 150, as determined by the method which is covered in detail in the third article of the present series. The bond itself consisted of a substance known as limonite, a form which iron oxide sometimes takes in nature, before time develops the hydrated iron oxide which is familiar in most good molding sands. The adsorption test as well as other tests showed the bond of the sand to be considerably too weak for average foundry use. This was also apparent by the feel of the sand which lacked the velvet adhesive quality belonging to a well-bonded sand. The next problem was to mix with this sand the substances which would give it the required bond. Inasmuch as 10 per cent of the weight of the sand was composed of the limonite it might have been possible chemically to alter this iron oxide so as to produce hydrated ferric oxide of the required bond strength. However, such a method would have meant considerable expense and therefore experiments were carried on with clays until finally a standard fireclay with a good bond was found, which when added to make up about 6 per cent of the resultant mixture produced a sand of excellent qualities. The clay was mixed by mulling and tempered with water and when the proportions to give the best results were determined, a car load of the sand was ordered and mixed with the bonding clay for foundry use. Tests of this sand after the introduction of the additional bonding material showed a

bond adsorption value of 350. Knowing the peculiarity of molders, the superintendent had the sand mixed only at night for each following day's work. On the first use of the sand it was spoken of as a sand from a new locality and was accepted with little comment, especially as it had a good feel and an appearance similar to that of the sand which had been used. The results from the new sand were excellent. The percentage of loss in castings after two months trial is well in line with the established record for the sand which had been previously in use, and the molders still remain in blissful ignorance of the fact that the new sand is artificial rather than natural.

Seeking Ideal Sand

The first article in the present series showed how in a molding sand properties which are responsible for good and for bad working conditions may be determined. Consideration of sands might broadly be classed under two headings.

Technical or intrinsic properties of the sand as it is placed in the hands of molders.

The purchase and development of sand from the economic as well as the practical standpoint.

The first consideration may again be divided into five headings.

Grain size
Bond
Refractoriness
Longevity

The appearance or feel which determines to some extent its handling property.

The first of these five items needs little elaboration, because it is so easy to specify positively a definite sieve test and its result. The sand for example may be described as one in which 80 per cent will pass sieves 80, 100 and 150, or it may be a sand of which not over 10 per cent will remain on sieves 20, 40 and 60. In fact, any refinement desired may be specified down to the actual percentage which is to remain on each of the sieves used. The second characteristic is somewhat more difficult to standardize.

As has been shown, the bond adsorption test is not sufficient completely to determine the working bond strength of a sand. For, assuming that the sand gives a definite determination of the amount of bond substance present, the density of that substance as it covers the individual grains of the sand still must be considered. Which means that the sand surface and therefore the grain size must be taken into account. The third item of refractoriness was treated in considerable length in the third article of this series, and is also a somewhat difficult characteristic to describe or standardize definitely.

Clays, and in fact, all bonding substances usually are regarded as refractory in nature, if they melt at temperatures above 2700 degrees Fahr. and as non-refractory if they melt below that temperature. However, this at best can only be an arbitrary figure for clays melting at 2600 degrees Fahr. would be of a refractory nature for low temperature work such as prevails in the casting of brass and other copper alloys. Also it is often the case with two sands which melt at practically the same temperature that one is much the superior because of the fact that it will resist a slightly lower temperature for a much longer period than the other. The fourth item has to deal largely with this property of resistance of temperatures below melting point. In any mold, there is a great variation in temperature between the sand which is furthest away, against the flask, and that which comes in contact with the metal. From the highest temperature which may break down the sand adjacent to the casting, to the comparatively low temperatures at the outside, there is a complete range of some 2000 degrees. Longevity means in its large sense, the property which a sand has for recovering its bond by tempering with water after the drying out which occurs during the pouring of each cast.

Sand Smoothness

Two sands may be practically identical as far as the first four properties are concerned and yet differ as to the fifth. The feel of sand is important. It cannot be described nor can sands be graded in writing, according to the feel. Yet, if a sand has not a good feel, molders will not like it and the work in a foundry therefore will not be as satisfactory, even though the laboratory tests indicate that the sand is admirably suited to the plant's use. It is almost impossible even in the laboratory to duplicate, with chemical exactness, a bond found in a good natural molding sand. However, it is possible to produce a sand with a good feel and this must therefore be given some consideration in any artificial sand modification. A sand, however, which conforms to good foundry requirements usually (though not always) feels right. The converse of this is less likely to be true for no amount of expertness in feeling sands can determine the temperature ranges at which they will melt.

On of the urgent needs of foundrymen as well as of sand producers is standardization along scientific lines of all molding sands. The problem is a difficult one but in no sense impossible and is sure to be solved as soon as foundrymen generally fully realize the important role which molding sands play in their business.

Shop Kinks that Eliminate Guess Work

AN APPRENTICE boy was attempting to bore ten holes ¾ x ½ inch in a pine board destined to form part of a pattern. He would bore a short distance, then remove the bit and measure the depth of the hole, put the auger bit back again and bore a little further. When the job was finished the holes were by no means of a uniform depth but ranged between 9/16 and 11/16 inch. When the boy had convinced himself by measuring that the holes were not as they should be he promptly hid the board under the bench and started on another one.

There are several ways of doing a job of this kind accurately. One way in particular that is practiced extensively is to slip a wooden sleeve over the bit and leave the tool exposed the required depth of the hole.

When I saw that the boy was about to repeat his former mistake I called him over and showed him a simple method for determining the depth of any hole he might want to bore in wood. I told him to start boring and when the cutting lips (not the parting or side lips of the auger) begin to cut, to commence counting. Using a ¾ inch bit I assured him that when he had counted nine full revolutions he could withdraw the auger and he would find that the hole was exactly ½ inch in depth. In other words a ¾ auger bit will advance exactly 1 inch in 18 revolutions, counting from the instant the flat lips commence to cut.

It is possible to secure data on the other size augers in the same manner and I advised the boy to test each one of his augers and make a note of the result in a memorandum book or on the cover of his auger bit box if he had one.

A surface planer is one of the most universally used tools in a pattern shop and yet comparatively few pattern makers familiarize themselves with its mechanism. Have you ever noticed a patternmaker dressing a board? The board in the rough is perhaps 1¼ inches thick and he wants to reduce it to ⅞ inch. He will pass it through the planer once, just skinning the surface. He hastens to the back of the machine to catch the board and places his rule against the

edge although ordinary common sense should tell him that the first cut has made no appreciable difference in the thickness. In all, he will probably pass that board through the planer half a dozen times and carefully measure it each time.

All or nearly all this measuring could have been avoided, if he had taken the trouble to examine the feed mechanism. This varies of course in different makes of planers but on the machine in the shop where I am employed, for example, a half turn of the feed wheel will result in removing 1/32 inch from the plank; a full revolution removes 1/16 inch and two full revolutions will remove ⅛ inch from the surface coming in contact with the knives.

This kind of information is easily acquired and remembered and will save a lot of time spent in unnecessary measuring.

How a Long Steel Flask is Assembled

BY GEO. W. CHILDS

THE splice bar shown in Fig. 2 has been found exceedingly efficient and quite an improvement on the old style of bolting up the ends of the flask side sections and having to depend entirely on the bolts for keeping the side of the flask rigid and in line. Flasks in which the splice bars have been employed to hold the side sections together have reduced the number of frames that have to be straightened under the steam hammer. The holes in the splice bar are spaced to correspond with the holes in the side of the flask. Extra long bolts are required for attaching the bars in the cope half of the flask at the 3-foot sections covered by the splice bar.

The bar, 9½ inches deep, 1½ inches thick, 3 feet long, is made of cast steel and weighs about 150 pounds. Sixteen 1¼-inch drilled holes are provided for attaching it to the sides of the flask. It is finished on the side which comes in contact with the flask side. The other side is spot faced for the bolt heads. The top and bottom edges are machined to a taper fit to produce a wedging action when the bolts are tightened, the inside corners of course being taken off to clear the fillet in the corner of the flask side.

Flasks for molding locomotive engine frames are made in what is known as the built-up type; with the sides in sections and separate end pieces, all bolted together. The sides are made in lengths of 6, 12 and 18 feet; weighing approximately 600, 1100 and 1700 pounds respectively. They are made in the usual channel style construction, having the web 1¼ inches thick; the top and bottom flanges 1½ inches thick by 4½ inches wide; and 13 inches deep over all.

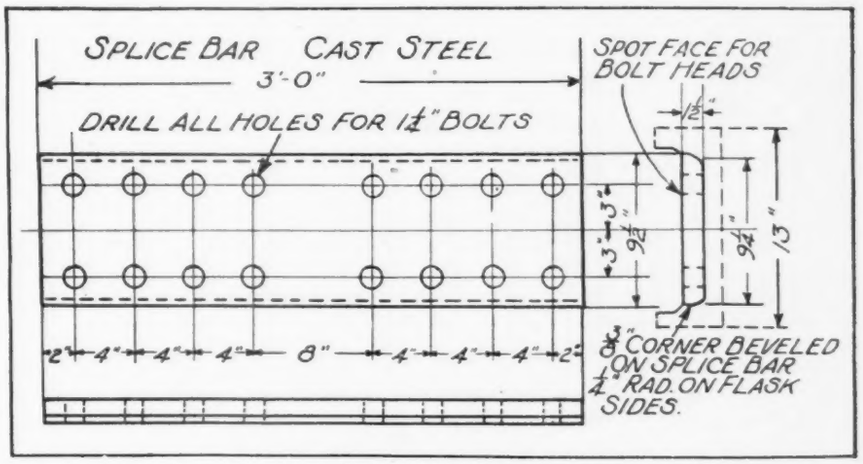


FIG. 2—DETAIL OF SPLICE BAR USED IN ASSEMBLING SIDE SECTIONS OF FLASKS USED IN MOLDING LOCOMOTIVE ENGINE FRAMES

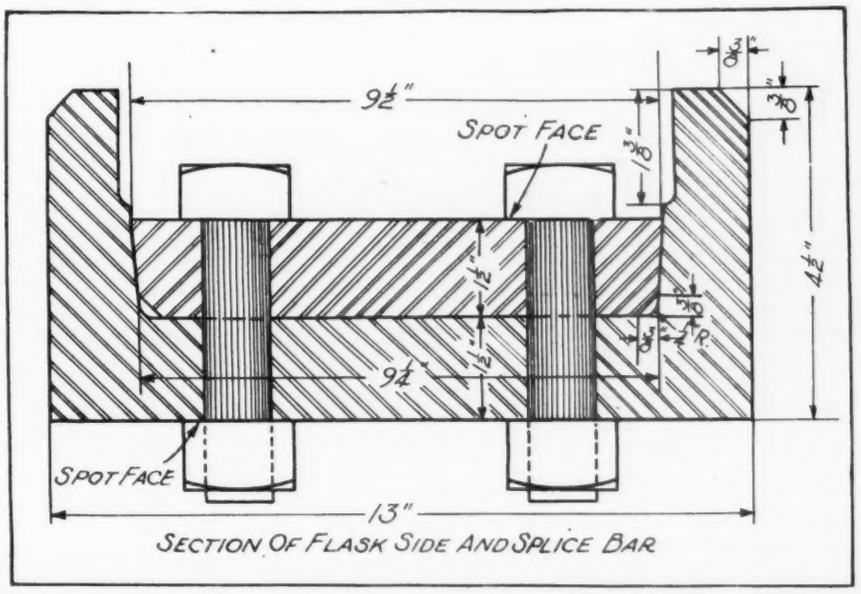


FIG. 1—SECTION OF FLASK SIDE AND SPLICE BAR

The web of the flask side is provided with a double row of 1⅛ x 2¼-inch cored holes equally spaced on 8-inch centers longitudinally by 6-inch centers vertically. These holes are for attaching the bars in the cope and drag and also for attaching the splice bars at the joints where the sections butt together. Vertical ribs, 1¼ inches thick, spaced about 2 feet apart on the outside of the flask sides extend from the top to the bottom flange. Holes drilled 1-inch in diameter and spaced 8 inches apart are provided in the flanges of the flask for securing the cope and drag parts together when the mold is assembled for pouring and also for attaching the bottom plates to the drag.

Flask ends as shown at *A* and *A* Fig. 4 weighing approximately 450 pounds each are provided, in addition to the usual flanges and ribs on the

outside, with two interior vertical flanges by which the ends are bolted to the sides. The ends are made 12 inches wide instead of 13 inches, the width of the sides. This obviates the necessity of machining them. A number of holes are drilled in the flanges of the ends for the same purpose as those in the sides.

The bottom plates made in sections of various lengths, but all the same width, that is 4 feet 9 inches. The plates are 1½ inches thick; the two end sections are 3 feet long and the plates between each 6 feet long each.

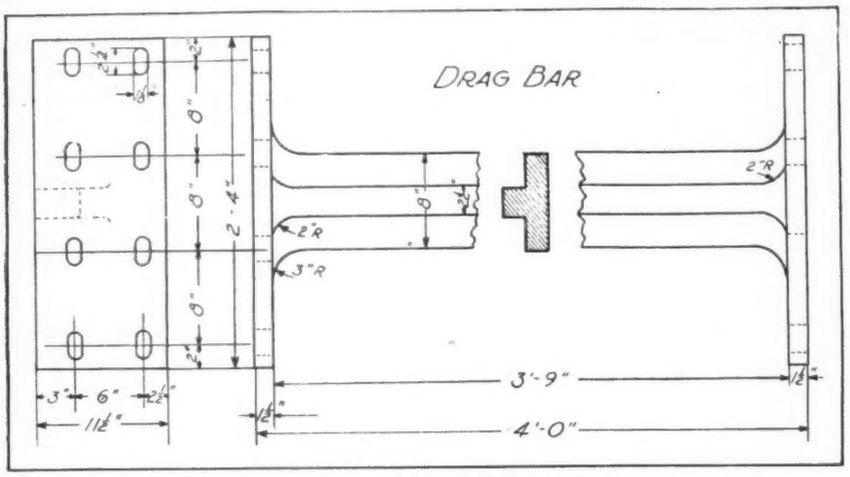


FIG. 3—DRAG BAR FOR LOCOMOTIVE ENGINE FRAME FLASK

The short plate weighs approximately 900 pounds and the long one 1800 pounds. Four cast-steel handles which weigh about 100 pounds each are attached to the cope and four to the drag. Each handle is secured to the flask by four 1-inch diameter bolts in the elongated cored holes previously mentioned.

When the over all length of the desired engine frame is known, the proper lengths of flask sides are selected and assembled. Locomotive engine frames weigh from 8000 to 10,000 pounds and are generally from 30 to 35 feet long, hence the assembled length of the flasks generally used is about 36 feet inside.

Fitting Up for Making Soil-Pipe Castings

Question: I have orders for a number of soil pipe connections; elbows, T-s, bends and straight sections. I should appreciate any information on how to make equipment that would enable me to handle this order by using green sand cores. I should also like to know how to make these green-sand cores, and finally, can hard iron be used to pour the castings?

Answer: The manufacture of soil pipe, both straight sections and specials, that is elbows, Y-s, tees and bends, is a highly specialized branch of the foundry industry. The equipment for making these pipes must be extremely accurate and the expense involved is only justified by large production. The entire supply for the United States is made in a small number of shops.

A complete description of the manufacture of soil pipe including the special fittings, would fill a book. Briefly it may be summarized as follows: The long straight lengths are made in close fitting cast iron flasks and generally poured with hand ladles *four up*. The ends of the flask are cut out to receive the ends of the arbors which are made to fit closely.

The practice employed in preparing the molds varies to a certain extent. In some plants the pattern is dropped part way through a stripper plate before the flask is lifted and in others the flask is lifted directly off the pattern plate. The only precaution observed in the latter case being that a vibrator is attached to the pattern plate and kept in motion during the lift.

The cast iron arbors are of comparatively heavy construction. They are provided in some cases with internal longitudinal ribs to prevent them from springing under the influence of the molten iron. Holes spaced at close intervals except in a line with the gates, serve to carry off the steam and gas generated during the process of pouring.

The finely screened sand for the cores is stored in an overhead bin or hopper which is constantly replenished by a bucket elevator running in close proximity to a revolving screen on the floor. The cast iron arbors are clay washed and placed one at a time on a suitable stand provided with bearings corresponding in size with the ends of the arbor. A crank handle fitted to one end is employed to turn the arbor around while a stream of sand is allowed to fall upon it from the overhead hopper. The stand holding the core is provided with a flat gage board which can be adjusted to regulate the thickness of sand on the arbor. Ten or twelve revolutions of the barrel produces a finished core.

In this connection is is only fair to point out that at least one manufacturer of soil pipe claims that he saves money by employing dried loam cores for the long, straight pipes. With the green sand core the discount is fairly heavy, especially if the iron is not *just so*. With the dried core this risk is eliminated and it is claimed that the increased number of good castings more than offsets the cost of drying the cores.

The molds for the elbows, tees, bends, etc., are made in the same manner as the molds for the straight pieces but the cores are rammed by hand. The arbor, which consists of a backbone with a number of semicircular wings cast on,

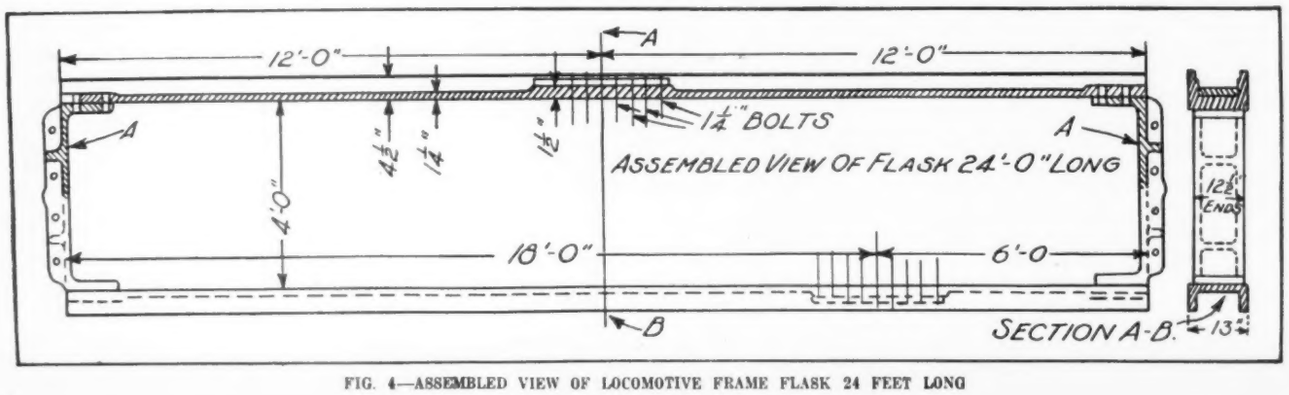


FIG. 4—ASSEMBLED VIEW OF LOCOMOTIVE FRAME FLASK 24 FEET LONG

only occupies the lower half of the core box. The corebox is made in two halves and hinged together at one or more points. This permits it to be opened after the core is finished. In the case of cores having three or more bearing points, like Y-s or T-s, short core prints are all that are necessary; but in the case of bent pipes with only two bearings it will be necessary to prolong the bearings to furnish sufficient leverage to overcome the *lift* of the iron as it flows in the mold.

So far as the utility of the pipes is concerned it makes no difference whether they are poured with hard or soft iron. However, owing to the fact that hard iron has neither the fluidity or running qualities necessary to pour castings of such an area and thin section as soil pipe, that kind of iron is automatically ruled out. A Southern iron high in phosphorus should be used in making these castings. It could be mixed with light machinery or stove plate scrap in varying proportions; a fair average being 40 per cent..

Pouring Castings Having Thin Sections

Question.—We should like to know how the casting shown in the accompanying sketch can be run with one gate. We are pouring them now with two runners at opposite sides. We notice that hollow ware, such as pots, kettles and sauce-pans, are cast bottom up with single runners in the center. It would save labor and be an advantage to us if we could run our castings in a similar manner. We have tried several times but the castings have always been dirty, streaked and cold shut. The molds are made in green sand and we use all scrap, as pig iron is costly and hard to obtain in this portion of Australia. Would the job be suitable for a jar-ramming machine?

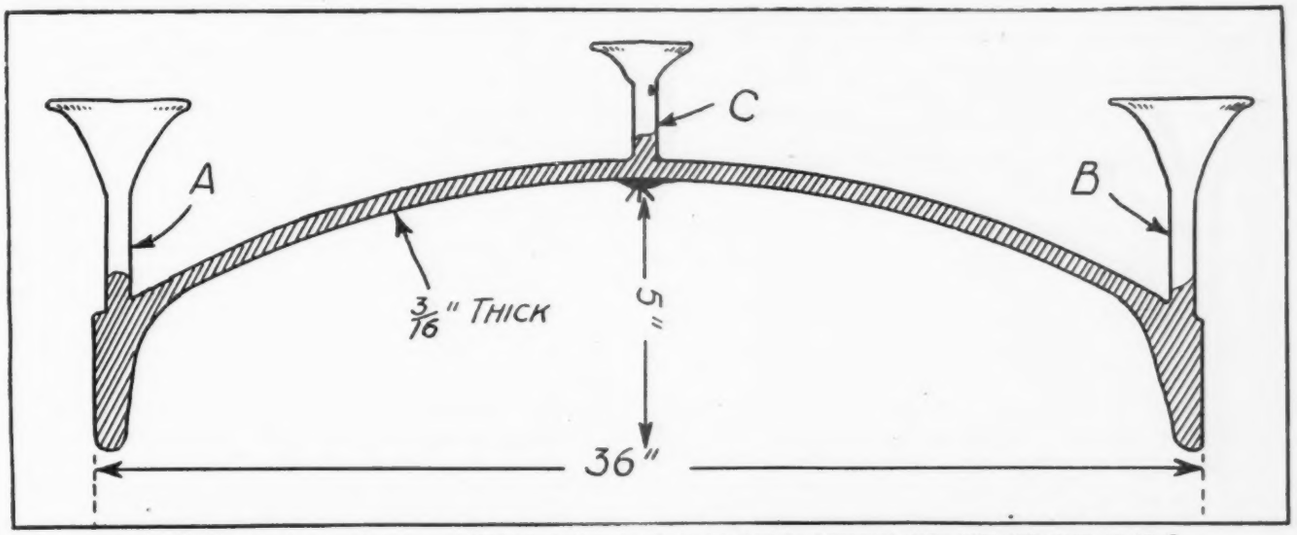
Answer.—A great part of your trouble is due to using all scrap in the cupola. It lacks fluidity and must be melted much hotter than a mixture made from pig iron and scrap. If it is possible to secure ferrosilicon we should recommend that you add about 10 pounds of 8 per cent ferrosilicon to each 1000 pounds of iron charged. This will materially increase its softness and running qualities.

The castings could be molded on a jar-ram machine. If you have a sufficient demand for them it would be a paying proposition. If the machine could be used only intermittently it is a question if the installation would repay the investment. With a pattern-draw, roll-over, jar-ram machine such as would be required for the casting under consideration, three men could put up about 50 molds a day, working piece work. In addition to the machine it would be necessary to furnish iron flasks with planed joints and with all pin holes drilled to a template in order to be interchangeable.

An alternative method would be to fit up a number of the same kind of flasks; but instead of mounting the pattern on a machine, prepare two follow boards, one for the cope and one for the drag, and ram the molds by hand. With this method two men could make about 25 molds a day working piecework. If conditions in your country are as we are led to believe and piecework methods do not obtain, you should have no difficulty in getting a production of 15 castings a day from a molder and helper.

The casting is only 5 inches deep with apparently a 2-inch flange and a 3-inch dome. Therefore, a 3-inch deep drag and a 6-inch deep cope would be sufficient. The drag would only require to be butted around the edge and tramped off in the center, while if the bars in the cope were a close fit, no gaggers would be needed and one ramming would be enough.

You might try pouring it from one runner in the center as shown in the sketch, but it would be prudent to ram a piece of cake core in the drag to receive the direct impact of the falling iron. However, a better method and one that cannot be poured with one ladle would be to slick off a space on top of the cope between two of the bars after it has been rammed, then with a ¼-inch sprue cutter, which is simply a piece of brass tube, punch three holes down to the pattern, about 6 inches apart in a straight line. After the mold has been finished and the cope replaced on the drag, a block of wood 1½ inches wide by 3 inches high and 2 feet long is laid over the holes, a runner box is set on to enclose the block and rammed full of sand. The block is then drawn out and a pouring basin is ready. It can be poured from one ladle. The three gates will furnish ample distribution for the metal and insure the casting running even if the metal should be dull.



THE PRESENT METHOD OF GATING IS SHOWN AT *A* AND *B*—IT IS DESIRED TO DISPENSE WITH THIS AND GATE AS AT *C*

A Correction

In the Oct. 1 issue of THE FOUNDRY, the halftone showing three micrographs on page 777 was reversed. In this way Fig. 7 became Fig. 9 and vice versa.

The new foundry of Peirce-Brown, Inc., North Tonawanda, N. Y., was officially opened by the pouring of the first heat on Friday, August the 13th. The company makes gray-iron castings.

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Light Needed on Sand Question

THE production of castings in iron, brass, steel, aluminum or any other metal hinges upon the close collaboration of so many factors, factors which are variable at all times, that at first glance it seems hopeless to attempt any standardization of any part of the process. The human equation enters so extensively into the business, so much depends on the skill of the hand and eye of the individual workman, that anything short of a general educational program to increase the individual knowledge of every man involved would seem to be wasted effort. However, upon consideration, it would seem that the very fact of so much depending on the individual judgment of the workman should form the strongest reason why material and processes should be standardized and regulated above the possibility of error.

Consider, for instance, the preparation of molding sand. Every intelligent foundryman knows that the relative size of his scrap pile depends as much upon the condition of his sand as upon any other factor. Indeed experience would seem to indicate that the condition of the sand at the time the metal is poured has more to do with the subsequent disposition of the casting than any two other factors. True, individual owners and superintendents here and there have established a fairly systematic routine in their shops which works out on an average satisfactorily; but even in those cases it will be found occasionally that the success of the system depends on the presence of an overseer, and once in a while he makes a mistake.

Experiment and research work on the part of the bureau of standards, American Foundrymen's association and many individuals working either on their own initiative or at the behest of large employing corporations have resulted in the establishment and recognition of certain standards by which castings shall be judged and their place determined in the broad field of industry. They must contain a predetermined amount of certain chemical elements. Test bars prepared in an arbitrary manner must withstand physical tests applied for the purpose of determining the ultimate strength of the casting under varying conditions. The results of this research work is in published form and is available to anyone, but that is as far as it goes. The individual foundryman's choice of raw material is not limited except in a general way. He is free to buy any material he likes and melt it provided the ultimate analysis corresponds with the required standard.

A considerable amount of research work also has been done on foundry sand. Standards have been established in some cases and in others recommendations for standardization have been submitted. As in the case of the metals, investigation has stopped after determining the physical properties and chemical analysis most suitable for any given class of work.

The best sand in the world, and this statement of course must be considered with certain reservations and with due regard to geographical position, will not produce good castings if it is too wet any more than it will work satisfactorily in the mold if it is too dry. It would appear that there is a splendid opportunity here for some national body to take the matter under consideration and work out a standard set of rules for wetting down and tempering the sand in a foundry.

Trade Outlook in the Foundry Industry

BUSINESS conditions at present are in a state of flux and likely will solidify only when a lower price level is reached on practically all commodities. Sudden cessation in buying, which has been characterized as a consumers' strike, has brought into all lines a condition of stagnation that is reflected by decreased plant operations, and in many cases by actual suspension of manufacturing. The foundry industry, which in some of its branches was among the first to feel the effects of the slump, is face to face with a knotty problem in co-ordinating costs with prices of castings.

Reason Must Govern

In some instances large users of castings who have furnished the bulk of the business for a number of jobbing foundries have urged that prices of castings must come down at once in order to absorb some of the loss in the sums received for finished products. That this is unreasonable in many cases is evident when it is considered that foundries almost without exception buy their raw materials on long time contracts, and in addition many within the past few weeks have been flooded by suddenly released shipments of sand, fuel and metal that were unobtainable a few months ago. Further, although labor is more plentiful, wages have remained fixed. In this way, the labor factor remains constant in the equation of cost, although greater efficiency is obtained than was evident during the busy season this summer.

Prices of Raw Materials for Foundry Use

CORRECTED TO NOV. 5

Iron		Scrap	
No. 2 foundry, valley	$45.00	Heavy melting steel, Valley	$25.00 to 25.50
No. 2 Southern, Birmingham	38.00 to 42.00	Heavy melting steel, Pittsburgh	25.00 to 25.50
No. 2 Foundry, Chicago	46.00 to 47.00	Heavy melting steel, Chicago	10.00 to 19.50
No. 2 Foundry, Philadelphia	45.50 to 51.50	Stove plate, Chicago	25.00 to 25.50
Basic, Valley	38.50	No. 1 cast, Chicago	29.50 to 30.00
Malleable, Chicago	46.50	No. 1 cast, Philadelphia	36.00 to 38.00
Malleable, Buffalo	46.25 to 48.25	No. 1 cast, Birmingham	31.00 to 33.00
Coke		Car wheels, iron, Pittsburgh	40.00 to 41.00
Connellsvill efoundry coke	$10.00 to 10.50	Car wheels iron, Chicago	34.00 to 34.50
Wise county foundry coke	15.50 to 16.50	Railroad malleable, Chicago	23.00 to 23.50
		Agricultural malleable, Chicago	23.00 to 23.50

Consider Malleable

One of the most striking instances of these conditions is furnished by the malleable castings industry. Recently completed reports for the quarter ending Sept. 30 show that pig iron and fuel have been purchased and stocked at peak prices. Then in the last few days of September, the increase in freight rates added a further burden to manufacturing costs. The quarterly figures show that the labor cost per ton of finished castings increased 11.3 per cent over the quarter ending June 30. It is stated that the labor item forms about 45 per cent of the total cost of malleable. Therefore, it plainly is evident that foundries which have a heavy overhead, and which in many cases have been operating at a narrow margin of profit may have difficulty in meeting any demand for lower prices. It is pointed out that the decrease in production due to slackening demand will serve to more than offset any possible gain through increased efficiency or greater production per man. It is interesting to observe the trend in the labor item of malleable costs. The first quarter of 1920 marked an advance of 4.05 per cent over the last three months of 1919. The second quarter added another 10.7 per cent and the quarter just past 11.3 per cent over the respective quarters preceding. Therefore, it is evident that an immediate reduction in malleable castings prices will be effected with difficulty. Malleable production in October showed a slight decrease, and it is thought that a further reduction will be noted in November. Most malleable foundries have orders sufficient to see them through the next 60 days, but new inquiries are scarce.

Gray Iron Slack

Gray iron shops which have been severely affected by the slump in automotive, constructive and machine tool lines entertain little hope of recovery before the first of the year. Perhaps those serving the latter industry may be the first to resume full operation, for it has been pointed out that the railroads which furnish a large cumulative demand for machinery will be forced within a short time to come into the market for replacement tools. The effort which is being made to repair and reclaim wornout rolling stock and motive power has placed a heavy burden upon railway repair shops, and these in many cases are demonstrating less than 40 per cent of prewar efficiency, due to depleted and wornout tools. The almost entire absence of inquiry for new railway equipment has removed the hope that this factor might serve to replace some of the lack of castings orders in other lines. A few railroads are buying cars and locomotives, but the sum total of this demand is not sufficient to bolster up losses in other quarters. Stove foundries have a fair volume of business from the recent flood of orders, but are apprehensive of the future when the public demands cheaper stoves. Heavy casting production except for the rolling mill industry is slack. Agricultural implement manufacturers continue to furnish a fair volume of business for foundries.

Slump Hits Raw Material

Coke prices continue on the decline due to the removal of a portion of the urgent demand from blast furnaces. October showed a higher output of pig iron, the total tonnage being 3,293,543 tons as compared with 3,124,308 tons noted in September, according to figures compiled by *The Iron Trade Review*. The average daily production of merchant pig iron was 26,436 tons in October, as compared with 26,604 for the preceding month. The significant feature of the compilation is furnished by a comparison of the number of stacks in blast. October showed a decrease of 28 stacks in operation, and a net loss of 16 among those making merchant iron. Nonferrous metal prices based on New York quotations of Nov. 5, follow: Casting copper, 14.62½c to 14.75c; lead, 6.60c to 6.75c; Straits tin, 38.50c to 38.75c; antimony, 6.37½c to 6.50c; aluminum, No. 12 alloy, producers' price, 32.00c, and open market, 24.50c to 25.00c. Zinc is quoted at 6.95c, East St. Louis, Ill.

Comings and Goings of Foundrymen

PROF. A. E. WHITE, one of the best known metallurgists in the country, has been installed as director of the industrial research laboratory at the University of Michigan, Ann Arbor. The laboratory now is functioning for the convenience of manufacturers of the state in solving problems of production. Professor White is president of the American Society of Heat Treaters and consultant of many plants throughout the country. The service of the new department will be paid for by manufacturers as they make use of its facilities.

William T. Stewart has resigned from the Unique Brass Foundry Co., Inc., Buffalo, N. Y.

H. E. Beckman recently has been placed in charge of the Newark, N. J., branch of the S. Obermayer Co, Chicago.

J. F. Geary, formerly assistant superintendent at the Chicago plant of the American Brake Shoe & Foundry Co., has been made manager of manufacturing for the Federal Radiator Co., Zanesville, O.

Harding Allen, of the Charles G. Allen Co., Barre, Mass., iron founder, has been appointed by Gov. Calvin Coolidge of Massachusetts a member of the Wachusett mountain state reservation commission.

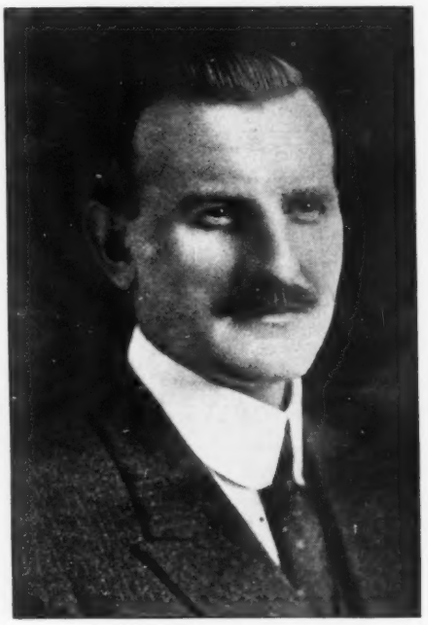
Konrad Schreier Jr., for the last three years secretary and treasurer of the Falls Motor Corp., Sheboygan Falls, Wis., manufacturing automobile and truck engines, tendered his resignation Nov. 1. Mr. Schreier will engage in business in Chicago.

W. R. Webster has resigned as assistant engineer of the Cambria Steel Co., Johnstown, Pa., effective Nov. 1, when he will become affiliated with the Semet-Solvay Co., Syracuse, N. Y., which now has a structural steel department in addition to its by-product coke oven and by-products business.

Joseph M. Jameson, vice president, Girard College, Philadelphia, addressed the Philadelphia Foundrymen's association at its October meeting, on the subject of "Education for Industry." The training of apprentices, part-time education through the co-operation of schools with industry and the subject of night school training were dwelt upon by this paper.

Herman P. Kruelen, who until recently was associated with the Chas. C. Kawin Co., Chicago, has been made western representative for the W. W. Sly Mfg. Co., Cleveland. Mr. Kruelen, during the war, was superintendent at the plant of the Wright-Martin Aircraft Co., New Brunswick, N. J. He recently has returned from an extended trip through Europe during which time he made an intimate study of foundry conditions. Mr. Kruelin will be in the Chicago office of the W. W. Sly Mfg. Co.

George E. Doke, formerly engineer of materials for the New York Central railroad with headquarters at Cleveland, has been appointed engineer of tests and transferred to the Grand Central terminal, New York. The vacancy at Cleveland has been filled by H. L. Hamilton, who is well known among foundries which supplied castings to the New York Central railroad, as he formerly was an inspector with headquarters in Cleveland.



EDWIN S. CARMAN
Newly elected president of the American Society of Mechanical Engineers

Bill Contrasts Ancient and Modern Practice

(*Concluded from page* 909)

walls of the mold to insure an even thickness of metal on each side. After all the cores had been set in their proper relative positions the cope was picked up and lowered on. Hook bolts were dropped through the openings left by the blocks and attached to the loops in the cores provided for that purpose. Wedges were slipped between the bottom edge of the bars and the face of the cores and then the bolts were drawn up tight. A short piece of pipe was set in each vent hole and the gaps in the cope rammed full of sand. The runner and risers were made up and then the cope with the cores hanging perfectly true, plumb and rigid, was lifted off. The pieces of plank were then taken out of the drag and the cope replaced. Simple; I'll say it was. Besides saving a few hours in the total molding time it insured a casting with an absolutely even section of metal."

"Yes," said Bill, "the foundry business is a great game and the man who thinks his practice cannot be improved upon should take a scout around the country once in a while to realize how little he really knows."

"If we don't take a scout down around the station pretty soon," I said, "I see where our friend misses his train."

"Lead on, MacDuff," said Bill. "I only wish I was going with him to the end of the road."

Sand Blast Devices Shown at Columbus

Economy of operation in sand-blast practice is in direct proportion to the application of the right devices to the work in hand. With this feature in mind the more progressive manufacturers of sand-blast equipment have extended their lines to cover practically every phase of the casting cleaning problem. The demand for automatic hygienic equipment to fill present day efficiency requirements has been met in a similar manner.

In the initial designs the rotary automatic table sand blast was limited in range of work; but its manifold advantages of continuous operation with large output, minimum labor requirements and removal of the operator from unsanitary conditions rendered it a popular model. Its continued popularity is assured by the fact that it is now available in many variations, one manufacturer producing no less than three systems of blasting action in five different sizes of machines to meet every usual condition.

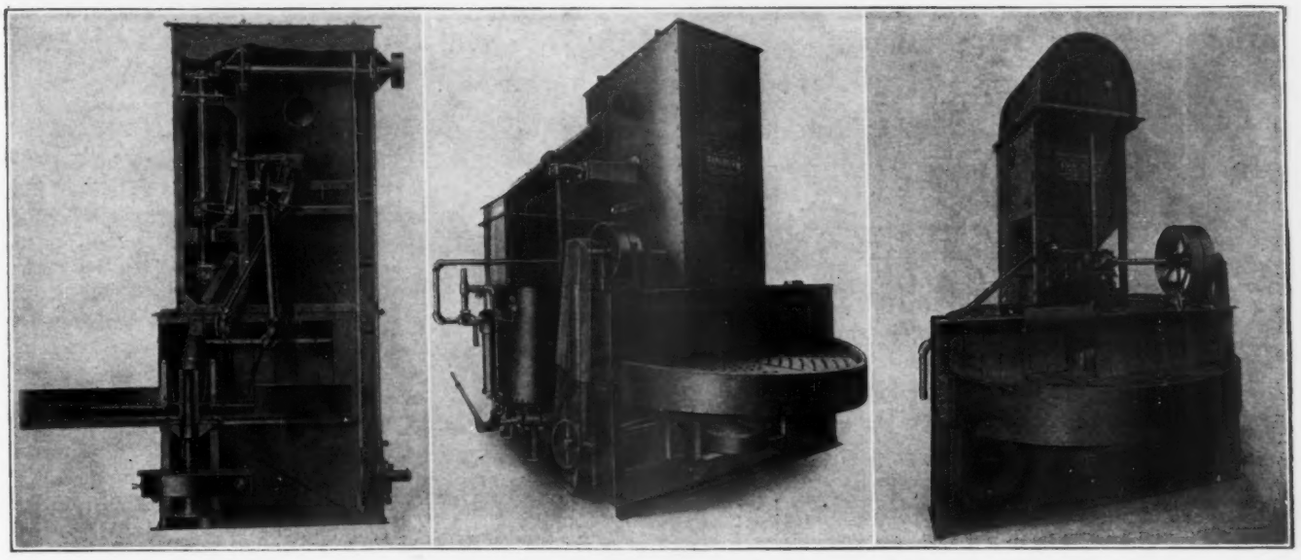


FIG. 1—ARRANGEMENT OF OSCILLATING NOZZLES AND SECTIONAL VIEW OF THE MACHINE SHOWN IN FIG. 2 FIG. 2—ROTARY TABLES AND BLAST MACHINE FIG. 3—GRAVITY FEED TYPE

The direct pressure system as illustrated in Fig. 2 is employed on large work and castings that are more than ordinarily difficult to clean. The blasting action is supplied through oscillating nozzles shown in Fig. 1, which cover the entire enclosed surface of the blasting zone. The machine is equipped with elevator and separator using both mechanical and exhaust means for reclamation and separation of the abrasive for reuse. The reclaimed abrasive is accumulated in storage bins from which the hose blast is instantly refilled through a quick acting valve that makes the operation practically continuous.

For work less difficult to clean or where the intensive action of the direct pressure is not necessary the gravity feed type shown in Fig. 3 is equally efficient and permits of an entirely self contained machine. Mechanical and exhaust action is used for reclamation and handling of the abrasive which is fed by gravity in a continuous cycle to the nozzles where the full force of the air is employed in the propulsion of the abrasive. The blasting action is entirely confined and the movement of the nozzles covers every portion of the work within the closed zone.

For light work, refinishing, etc., the self-contained suction feed type provides a small compact machine that adapts itself readily to conditions. The used abrasive is reclaimed through screens and carried by suction or siphon to the nozzles. The nozzles on this machine have a vertical adjustment to allow any distance between 5 and 12 inches between them and the table top. As to capacity it is claimed that upward of 50,000 victory medals were matte finished daily on one of these sand-blast machines. A large size machine has a table diameter of 70 inches with 12 inches clearance between the nozzles and the table top. This makes it adaptable for reasonably large work or a large quantity of small pieces. Like the other models the blasting action is entirely confined and the nozzle movement covers the entire area of the blasting chamber. The equipment shown in the accompanying illustrations is manufactured by the Pangborn Corp., Hagerstown, Md. ,and several of the models were shown for the first time at the exhibition held in conjunction with the convention of the American Foundrymen's association at Columbus, O.

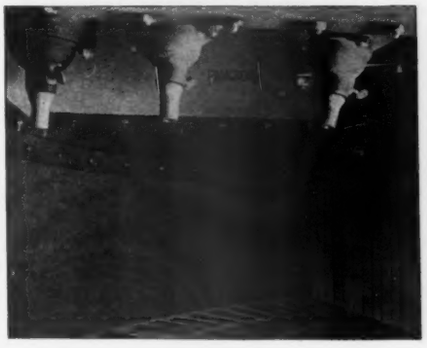


FIG. 4—ARRANGEMENT OF STATIONARY NOZZLES DESIGNED TO COVER THE ENTIRE TABLE

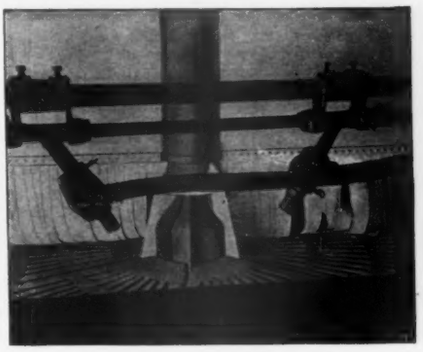


FIG. 5—MOVABLE NOZZLES SET TO COVER BLASTING ZONE

Foundry Purchased

The American Steel Products Co., Johnstown, Pa., recently organized with a capital stock of $300,000, has purchased the foundry of J. V. Hughes & Co. at New Florence, Pa., and has started operations in its new plant. A 2-story structure adjoining the foundry also has been taken over by the Johnstown concern and will be remodeled and equipped for the manufacture of automobile accessories and other steel and aluminum articles.

Melting Furnace Operates on Motor Circuit

A simple type of electric melting and refining furnace operated directly on a 220-volt motor circuit, without transformers, has been designed by Frederick Von Schlegell, of the Industrial Electric Furnace Co., 53 West Jackson boulevard, Chicago, and is being put on the market by that company.

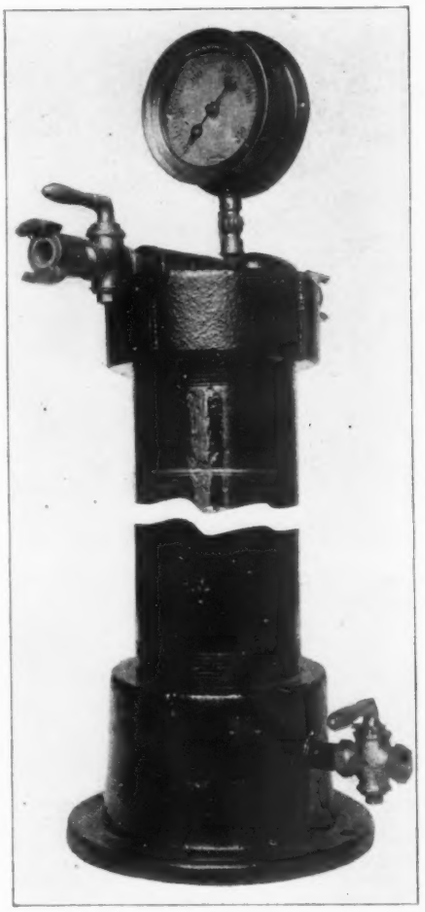
The arcs are drawn, sustained and regulated by a balance system automatically giving stability and the builders claim that the operator requires no electrical knowledge. It is built with capacities of from 300 pounds to one and one-half tons per heat. It is stated it will melt or refine all ferrous and nonferrous metals which can be worked in cupola, open-hearth, air furnace, crucible or electric furnaces.

Smaller sizes are designed for brass foundries, for special tool steel work,

small castings, for melting alloy for larger furnaces, making metal patterns, and for emergency or development work in large steel and gray-iron foundries.

The furnace consists of a refractory-lined shell or body, the heat element being suspended through the roof. This element is in effect an electric arc torch, which diffuses a large, intensely hot flame. The shell is cylindrical and of extra heavy steel plate. It is mounted on a portable steel frame and special concrete foundations are unnecessary. Heavy rocker trunnions support the shell and allow it to lock after pouring. Tilting is by hand and all mechanical tilting equipment has been eliminated. If desired the furnace shell with its charge of molten metal can be lifted by a crane and pouring can be done direct from the furnace into molds without using a ladle. The furnace is built for single-phase, three-phase or direct current. With single-phase or direct current, two electrodes are used and with three-phase, three electrodes. They are held in place by a refractory sleeve so mounted that the sleeve and electrodes can be raised or lowered or swung aside to permit charging through the top opening of the furnace. This does away with side doors and prevents loss of heat.

The furnace is lined with an insulating coat next to the shell and a ganister lining mixed with a small percentage of fireclay and a pine tar product is rammed in place with air rammers. If desired, carborundum sand can be used instead of ganister. If basic lining is required it is made with magnesite and dolomite with basic slag and hot anhydrous tar for a binder. The roof is formed of 18 fireclay brick, 9 x 4½ x 2¼ inches, a standard size.



DEVICE FOR REMOVING DIRT AND MOISTURE FROM COMPRESSED AIR LINE

New Type Air Separator

The air separator shown in the accompanying illustration recently has been placed upon the market by the Independent Pneumatic Tool Co., Chicago. The air enters the separator through two pipes located near the top of the device. It strikes the inside casing or wall at an angle thereby giving it a centrifugal motion which causes any entrapped water or dirt to fall to the bottom where it may be drained off. Clean air passes through the separators into the pipe line. It is claimed that the device will eliminate sticking of valves and pistons in pneumatic tools, a phenomenon common enough when the air carries any appreciable amount of dirt or moisture. The separator is made in two sizes, one having a capacity of 150 cubic feet and the other 400 cubic feet.

Iron Melted in a Crucible

Question—Occasionally it is necessary for us to make a few gray-iron castings. Not having a cupola we melt the metal in a crucible in one of our brass furnaces. The gates and sprues are placed in first. Then a pig of iron is broken and added on top of the scrap. We have no trouble in securing hot iron but find that it always is hard. What shall we do to secure soft iron castings? *Answer*—The scrap and pig iron should be placed

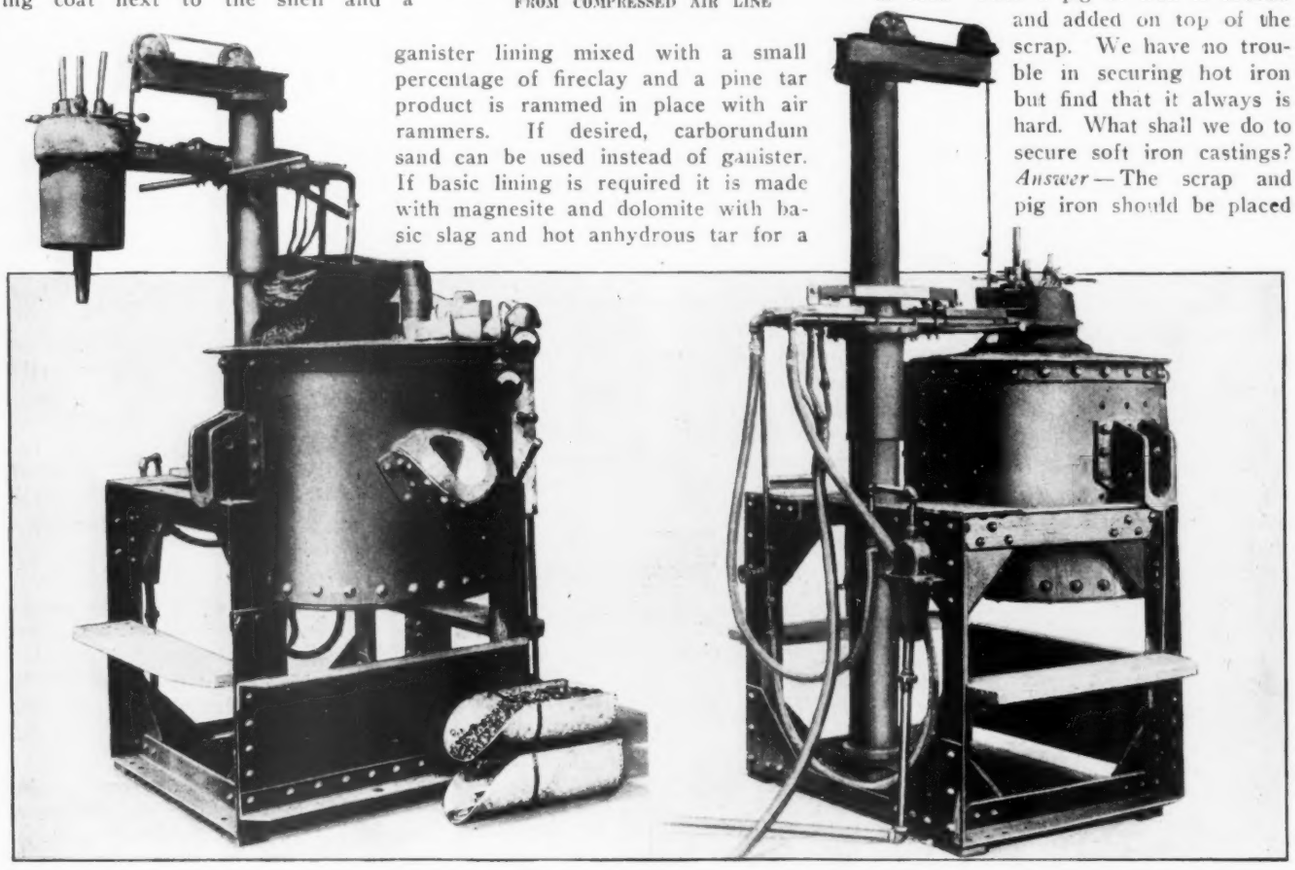


FIG. 1—FRONT VIEW SHOWING CHARGE READY TO BE PUT IN TOP OF FURNACE FIG. 2—SIDE AND REAR VIEW OF FURNACE IN MELTING POSITION SHOWING ELECTRICAL CONNECTIONS

in the crucible as is your custom but some charcoal should be mixed with it, preferably in layers. Sufficient charcoal should be added so that there is some of it remaining on top after the iron is melted and ready to pour. If a fair grade of scrap is used and 25 per cent of No. 1 pig iron is added you should have no trouble with hard iron. If the iron is still hard add a small amount of ferrosilicon.

Book Review

Fuel Oil in Industry, by Stephen O. Andros; cloth; 274 pages, 5¾ by 9 inches; published by the Shaw Publishing Co., and for sale by THE FOUNDRY; price $3, postpaid.

This book carries the reader through the complete utilization of oil as a fuel and explains the attendant principles governing the use. Chapters include subjects as follows: Principles of fuel oil combustion; physical and chemical properties; comparison with coal as fuel; distribution and storage; heating and straining, pumping and regulating; arrangement of boiler furnaces, types of oil burners, use in steam navigation; oil burning locomotives; the manufacture of iron and steel; heat treating furnaces; use in production of electricity; use in sugar industry; use in the glass industry; connection with the ceramic industries; heating public buildings and residences; and, oil in gas making. The appendix deals with the general uses of fuel oil. Approximately 100 operations, in which this fuel is used for heating, are enumerated in alphabetical order. Illustration of the content is provided with 107 engravings many of them occupying a full page. Tables are included on subjects such as boiler efficiency, analyses of oils, specific gravity equivalents, locomotive fuel tests, stack sizes for oil fuel etc.

What the Foundries Are Doing

Activities of the Iron Steel and Brass Shops

The Reh Tool, Steel & Foundry Co., Plymouth, Mich., recently increased its capital stock to $64,000.

Randolph Ember, 11 King street, Brooklyn, N. Y., is building a foundry building, 56 x 96 feet.

The Wagner Mfg. Co., Sidney, O., is building an addition to its foundry, 80 x 180 feet.

Dave Stewart, Clio, S. C., is reported planning to equip a machine shop and foundry.

The Swartz Iron Foundry, East Freeport, Ill., has bought the carnival grounds, Taylor avenue, on which it contemplates the erection of a plant.

The Union Stock Yards Casting Co., Chicago, is reported planning the erection of a foundry, 60 x 125 feet, at 4935-53 South Morgan street.

The Brown Clutch Co., Sandusky, O., is reported planning the erection of a foundry building, 100 x 128 feet.

The Newman Foundry Co., Kendallville, Ind., recently increased its capital stock from $25,000 to $50,000.

The Berlin Foundry & Machine Co., Berlin, N. H., has had plans prepared for the erection of an addition to its foundry, 60 x 110 feet.

The Manufacturers Foundry Co., Waterbury, Conn., recently increased its capital stock from $200,000 to $400,000.

Work will be started in the spring on the erection of a foundry at Portland, Conn., for the Wilcox, Crittenden & Co., Middletown, Conn.

The Mutual Enamel Works Co., Chattanooga, Tenn., is having plans drawn for the erection of a foundry and enamel works.

The Worcester Foundry Co., Inc., Worcester, Mass., is building an addition to its plant 60 x 148 feet.

The Cambridge Foundry & Machine Co., Cambridge, O., is building an addition to its plant, 80 x 120 feet.

The Eastern Malleable Iron Co., Naugatuck, Conn., has had plans prepared for the erection of an addition to its branch plant at Union City, Conn.

The capital stock of the Detroit Steel Casting Co., Detroit, recently was increased from $600,000 to $1,300,000.

P. L. W. Dupre, 20 James street, Montreal, Que., is taking bids for the erection of a brass foundry and other plant buildings, for G. Dupont.

Lewis & Gray, 156 Main street, San Francisco, manufacturer of iron specialties' has had plans prepared for the erection of a new plant building.

Contracts have been awarded by the Vulcan Iron Works, New Britain, Conn., for the erection of an addition to its foundry, 90 x 100 feet.

The Pontiac Foundry & Machine Co., Pontiac, Mich., has been reorganized as the Pontiac Iron Works with a capital stock of $30,000.

The National Casting & Foundry Co., Decatur, Ill., has had plans drawn for the erection of a foundry, 60 x 64 feet,

Erection of an addition to its foundry, to be 50 x 75 feet, is planned by the H. Kasden Co., 19 Howe street, New Haven, Conn.

Morris and Samuel Siegel and others of Philadelphia, are organizing the Jefferson Brass Foundry & Mfg. Co.

The Vulcan Foundry Co., Philadelphia, is being organized by Frank A. Moorshead, Commonwealth building, Philadelphia, and others.

The Eastern Foundry & Machine Co., Philadelphia, Liberty building, has awarded a contract for the erection of a plant, 60 x 120 feet.

Contracts have been awarded by the Jorgenson Mfg. Co., Waupaca, Wis., for the erection of a brass foundry, 80 x 122 feet, to be equipped with five electric melting furnaces.

Capitalized at $25,000, the Wright-Dance Range & Furnace Co., Knoxville, Tenn., recently was incorporated by R. F. Wright, J. M. Dance and C. O. Pennington.

The John R. Forbes Foundry & Iron Works, Jersey City, N. J., has been organized by John R. Forbes, 505 Valley Place, South Orange, N. J., and others.

The St. Louis Malleable Casting Co., 7701 North Conduit avenue, has awarded a contract to the Fruin & Colnon Co., for the erection of a foundry building, 100 x 465 feet.

The Damascus Tool Co., Pittsburgh, is being organized by George W. Evans, William G. Prescott and George W. See, to engage in the manufacture of tools, machine parts, castings, etc.

The Armstrong Foundry Co., Racine, Wis., which has been making improvements to its plant, recently increased its capital stock from $75,000 to $150,000.

The Federal Foundry Supply Co., Cleveland, 2633 East Seventy-ninth street, has acquired five acres at North Charleroi, Pa., on which it plans to erect a foundry. It is expected the plant will be ready for occupancy about the first of the year.

The Doud-McFarlane Machine Co., Tacoma, Wash., has purchased a site on which it plans to erect a plant which will include a foundry, 80 x 300 feet, a galvanizing and pattern shop and a manufacturing building, 50 x 170 feet.

The foundry and machine shop formerly occupied by the International Hoist Co. at Antigo, Wis., and the Pioneer Iron Works, has been taken over by the Antigo Foundry Co. The plant is undergoing rehabilitation.

New machine tool and other equipment will be purchased by the Yates-Johnson Co., Chippewa Falls, Wis., for the second unit of its machine works, 48 x 100 feet. The capacity of the foundry is also being enlarged.

Walter and Otto Leinau who have been engaged in the brass and aluminum casting business for some time at Sheboygan, Wis., have incorporated the business as the Leinau Brass & Aluminum Foundry, Inc., with a capital stock of $25,000.

The new shop building to be erected by the Pomona Mfg. Co., Pomona, Cal., manufacturer of iron castings, machinery, etc., will be 82 x 160 feet. It will be equipped with an electric traveling crane.

The McKenna Brass & Mfg. Co., First and Ross streets, Pittsburgh, manufacturer of automatic bottling machinery, etc., has recently acquired the plant and business of the Joseph F. Haller Co., Chartiers and Cliff streets, manufacturer of similar machinery, which it will operate as a branch works.

The Worthington Pump & Machinery Corp., New York, is receiving estimates from Cincinnati contractors, for the erection of an addition to its Laidlaw Works at St. Bernard, O. The addition will be 1-story, 50 x 75 feet, and will be used as a cleaning room.

The Pittsburgh Malleable Iron Co., Thirty-fourth and Smallman streets, Pittsburgh, manufacturer of iron and steel castings, is having plans prepared for the erection of a new foundry building, to be 200 x 320 feet. Frank D. Chase, Inc., Chicago, is architect.

Plans are being made for the construction of the first unit at Miley avenue and West Michigan street, Indianapolis, of a large foundry by the Lavelle Foundry Co., which now operates a plant at Anderson, Ind. The company eventually will construct two more units of equal size.

All the machinery and equipment of the General Aluminum & Brass Co., South Park, a suburb of Port Huron, Mich., is being removed to the Detroit plant. It was reported that the company had planned

to enlarge the main works at Detroit, rather than maintain branch plants at South Park and Marysville, Mich.

The Hancock Steel Co., Hancock, Md., has been incorporated with a capital stock of $500,000, to engage in the manufacture of iron and steel, manganese, brass and bronze products. It has acquired a site at Brosius, W. Va., on which it plans to erect a plant. J. Franck Shields is president and Roy N. Daniels, secretary-treasurer.

The Rochester Castings Corp., Rochester, N. Y., is having plans prepared for the erection of a foundry, 275 x 1000 feet.

The Florence Foundry Co., Florence, N. J., has awarded a contract to L. M. Shertack, Philadelphia, for the erection of a foundry building, 55 x 100 feet.

The American Steel Products Co., Johnstown, Pa., recently organized with a capital stock of $300,000, has purchased the foundry of J. V. Hughes & Co., at New Florence, Pa., and has started operations. A 2-story structure adjoining the foundry building, also has been taken over and will be utilized for the manufacture of automobile accessories, etc.

Of brick construction with steel trusses and a monitor roof over the fires, the proposed foundry of the Jefferson Brass Foundry, 209-11 King street, Brooklyn, N. Y., will be 40 x 96 feet inside dimensions. It will be equipped with 12 furnaces, and provision will be made for the installation of additional furnaces as needed. A crane will travel the entire length of the building.

Officials of the Pioneer Brass Co., Indianapolis, have announced the company will build three additional buildings to its new plant which is now under construction. In addition to the plant as originally designed and now under construction, another foundry building, 150 x 200 feet, a machine shop, 75 x 200 feet and a pattern building, 50 x 50 feet, will be erected.

Fully equipped for the manufacture of tire molds and cores for rubber and automobile manufacturers as well as to do general machine work, the Plummer Machine Co., Ltd., 80-82 Chestnut street, Toronto, Ont., recently was organized with a capital stock of $100,000. The company, of which A. Plummer is president, also produces aluminum castings.

The Star Car & Foundry Co., Huntington, W. Va., recently incorporated with a capital stock of $750,000, will comprise a merger of the Ohio Valley Mine Car & Mfg. Co., Huntington, W. Va., and the Star Car & Mfg. Co., New Lexington, O. It is planned to concentrate operations to a large extent at the Huntington plant, and plans are under way to increase the capacity from 40 to 100 steel mine cars a day. J. C. Shirer is president.

The Western Malleables Co., Beaver Dam, Wis., has placed in operation the sixth and last furnace of its three unit plant. This is the first time in more than two years that all of the furnaces have been in operation at one time. The Center street shop has been undergoing improvement work during the past year and will handle small casting orders for railroads and for the automotive industry.

Involving an expenditure of approximately $3,500,000, the American Car & Foundry Co., New York, is making improvements to its plant at Buffalo. The new plant, now under construction, will be utilized to build all-steel cars at the rate of from 20 to 30 daily. It will be equipped with the most modern machinery and tools. The company's soft-iron foundry has been completely re-equipped and is now engaged in quantity production.

The American Metal Products Co., 671 Kinnickinnic avenue, Milwaukee, has decided to postpone until next spring, the construction of a new foundry and machine shop on a site at West Allis, Wis. Plans prepared by George Staal, consulting engineer, will be held in abeyance. The plant will consist of a brass and gray iron foundry, 50 x 75 feet and a machine shop, 75 x 150 feet. The company manufactures brass and bronze castings. Carl J. Zaiser is secretary and treasurer.

Of steel and brick construction with steel made sash and concrete floor, the extension to the machine shop of the Excelsior Tool & Machine Co., East St. Louis, Ill., measures 70 x 110 feet making the total length of the shop 320 feet. The extension will be utilized for assembling the machines manufactured by the company, comprising power shears, arch presses, punch presses, polishing lathes, etc. The company's new foundry extension is 80 x 118 feet and is of steel and concrete construction. Two cupolas have been installed with a melting capacity of 10 to 15 tons per hour. Two core ovens are located near the center of the foundry and the storage racks are conveniently located near the molding floor.

Advices have been received from the Mack Mfg. Co., Ltd., Houston, Tex., manufacturer of oil field supplies, to the effect it recently increased its capital stock from $500,000 to $2,000,000. The additional capital is to be used in financing the erection of plant additions and the installation of new equipment. The company operates a steel and gray iron foundry. In addition to these improvements, the company is planning to erect a branch plant in either northern Texas or Oklahoma, which will be devoted to the manufacture of cable tool equipment. Officers are: President, J. O. Mack; secretary, H. L. Sadler, and plant superintendent, Charles R. Edwards.

New Trade Publications

PNEUMATIC TOOLS.—A 4-page illustrated folder has been issued by the Independent Pneumatic Tool Co., Chicago, in which pneumatic tools are illustrated. These include air drills, hammers, motor hoists, etc.

BUCKETS.—A small colored folder containing a discussion of lever arms, rated capacities and S-bends, as applied to clamshell buckets, is being circulated by the Blaw-Knox Co., Pittsburgh.

ARC WELDING.—The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has published a 24-page bulletin on arc welding principles and processes. The book is made up of reprints from various technical papers and magazines.

WELDING AND CUTTING.—The Bastian-Blessing Co., Chicago, has published a 36-page illustrated booklet in which welding and cutting equipment is described and illustrated in detail.

VENTILATORS.—The Merchant & Evans Co., Philadelphia, is circulating a 20-page illustrated bulletin in which metal ventilators for use on industrial structures and other buildings, are described and illustrated.

CONVEYORS.—The Godfrey Conveyor Co., Elkhart, Ind., has published a 16-page illustrated booklet in which an overhead conveying system for the transportation of coal, and other materials is described and illustrated.

CRANES.—Electric traveling cranes, bridge and gantry cranes, hand power cranes, pillar and jib cranes, , etc., are described and illustrated in a 32-page illustrated booklet recently published by the Northern Engineering Works, Detroit.

POWER TRANSMISSION MACHINERY.—The A. & F. Brown Co., Elizabethport, N. J., is circulating a 130-page illustrated booklet in which power transmission machinery and equipment are described and illustrated. Full data and specifications are given.

STEEL BUILDINGS.—Industrial steel buildings, of the standardized type are described and illustrated in a folder being circulated by the Steel Fabricating Corp., Harvey, Ill. These buildings are furnished in three types.

SAND TEMPERING.—The American Foundry Equipment Co., which has been merged with the Whiting Corp., New York, is circulating an illustrated booklet in which the use of a sand cutting machine in a malleable foundry is pointed out.

ELECTRIC HOIST.—A cardboard folder has been prepared by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., in which electric hoists for handling heavy material are described and illustrated. These hoists may be controlled either from the floor or from a cage.

MOLDING MACHINE.—The Whiting Corp., New York, has prepared a 16-page illustrated booklet in which molding machines are described and illustrated. These machines are of the one man, hand and foot operated type and require no power and no special skill to operate, according to the booklet.

CLAMSHELL BUCKETS.—A type of clamshell bucket designed to meet the requirements of steel works in handling broken slag, limestone and hard ores, is described and illustrated in a folder being circulated by the Blaw-Knox Co., Pittsburgh. The folder gives specifications, etc.

STEEL BUILDINGS.—Structural steel buildings, built in standardized styles, types and sizes, are described and illustrated in a folder recently published by the Steel Fabricating Corp., Harvey, Ill. The illustrations show exterior and interior views of industrial buildings of this type which have been erected.

ELECTRIC FURNACES.—The Acheson Graphite Co., Niagara Falls, N. Y., is circulating a 58-page booklet in which data pertaining to the use of the electric furnace are given. The information includes a description of the various electric furnaces, by the manufacturers, and includes not only those made in the United States, but also Canada and Europe. The booklet is interesting.

FOUNDRY EQUIPMENT.—A new booklet is being circulated by the Whiting Foundry Equipment Co., Harvey, Ill., which describes the layout and equipment of complete foundry plants, including gray iron, steel, brass, , car wheel and malleable iron foundries. The booklet contains 49 pages and is profusely illustrated, showing parts of various well known foundries.

METALWORKING MACHINERY.—The F. B. Shuster Co., New Haven, Conn., is circulating its general catalog, which consists of seven bulletins under one cover, each bulletin devoted to a separate subject. The machinery described includes: Automatic wire straightening and cutting machines; wire straightening machinery; riveting machines; wire forming machinery; sheet metal and strip metal straightening and cutting machinery and geared straightening and cutting machinery. The bulletins are illustrated and specifications and other data given.

FOUNDRIES.—Frank D. Chase, Inc., Chicago, has published an illustrated booklet in which a number of representative foundry plants which the company has erected are illustrated and described in a general way. The plants shown include, the Samson Tractor Co., Janesville, Wis.; Chain Belt Co., Milwaukee; Des Moines Foundry & Machine Co., Des Moines, Iowa; Temple Malleable Iron & Steel Co., Temple, Pa.; General Motors Corp., Saginaw, Mich.; and Manning, Maxwell & Moore, Inc., Muskegon, Mich.

MARINE PUMPS.—The Worthington Pump & Machinery Corp., New York, has published a 126-page illustrated booklet in which marine pumps and pumping machinery auxiliaries are described and illustrated. The booklet is divided into five sections, the first section being devoted to reciprocating pumps; the second, air pumps and condensers; the third, oil pumps; the fourth, centrifugal pumps and the fifth, miscellaneous marine auxiliaries.